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MISSOURI BOTAN

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THE SOCIETY OF ETHNOBIOLOGY CONFERENCES

1. Prescott, Arizona - 1978
2. Flagstaff, Arizona - 1979
3. Tucson, Arizona - 1980
4. Columbia, Missouri - 1981
5. San Diego, California - 1982
6. Norman, Oklahoma - 1983
7. Seattle, Washington - 1984
8. Cambridge/Boston, Massachusetts - 1985
9. Albuquerque, New Mexico - 1986
10. Gainesville, Florida - 1987
11. Mexico D.F., Mexico - 1988
12. Riverside, California - 1989
13. Tempe/Phoenix, Arizona - 1990
14. St. Louis, Missouri - 1991

As one who has participated in all thirteen annual conference and as one who has listened to and remembered the comments of many others, I wish to address what I and others have most enjoyed about them and to mention some areas of concern. I applaud the efforts of all those who have organized these events. All thirteen conferences have been successful especially in the important areas of human interaction and the stimulation of ideas. I am grateful for each of them.

The first Conference was a relatively small one held in Prescott, Arizona. It was organized to honor Lyndon L. Hargrave who died shortly thereafter. Although most of the participants were from the American West,there was a sprinkling of ethnobiologists from other parts of the U.S.A. The second Conference, in honor of the late Hargrave and Alfred Frank Whiting, was held at Flagstaff, Arizona. It was somewhat larger and attracted ethnobiologists from farther afield. Tucson, Arizona was the location of the third Conference and the innovations introduced at this meeting started a trend of adding new things, while (usually) retaining the best of the old. This 1980 meeting brought the first small contingent of ethnobiologists from Mexico and participation of Native Americans. Generally, the conferences have improved over the years with arrangements becoming increasingly professional but with a warm, family flavor.

Poster Sessions, as I recall, were first introduced at the 1980 meeting and have been an "on again, off again" feature since. It seems to me the most successful and rewarding poster sessions have been at the Mexico City and Riverside conferences. A full morning was given to the poster session and adjacent book fair in Mexico City and an evening was devoted to this activity at Riverside. Poster presentations are most effective and successful, in my view, when they have been conceived and planned as such from the beginning. Conference organizers should give attention to poster sessions early in their planning. When poster presenters are accorded a convenient space and ample time for their presentations—both free of distractions—conference participants will more likely consider the Poster Session a forum worthy of their efforts.

Over the years conference program booklets have improved considerably because, in part, of increased availability of computer technology over the past thirteen years. It's now much easier to produce a booklet with a professional appearance at a reasonable cost than it was a decade or more ago. Full addresses for all conference presenters were given at the back of the booklet prepared for the 1989 conference. This was much appreciated and most helpful and should be a standard feature for future booklets. I'm always interested in what the local committee will decide upon as a logo for the conference and the booklet each year.

In the early years there was only one business meeting. Officers and board members usually met over a hurried luncheon and discussed a hastily prepared—sometimes impromptu—agenda. In retrospect it all seemed rather casual. The General Business Meeting, open to all who attended, was introduced at the Albuquerque meeting in 1986. Although it is difficult to find a time slot for such a meeting, I think it is important to do so. This is the only provision for the membership to participate in the operation of the Society. It generates a sense of family—something the Society has always had and will want to nurture. We now have a Board of Trustees Meeting and an Editorial Board Meeting, each lasting about three hours. In recent years these meetings have been held the day before the conference officially opens. The Minutes of the Editorial Board Meeting are now published in the *Journal*.

Those who attended the Conference in Phoenix (1990) experienced the advantages and frustrations of simultaneous sessions. The basic advantage is to provide a greater number of time slots for contributed papers than would be possible without them. Frustration often arises when one wants to hear talks scheduled at the same time. Although increasing the length of the conference would accomplish the same objective as simultaneous sessions it will also increase expenses for participants because of additional lodging and meals. I suggest the Society circulate a questionnaire—perhaps mailed with renewal and election notices—soliciting the feeling of members about simultaneous sessions, poster sessions, etc. In the meantime those with opinions to express about these or other matters can write to the News and Comments Editor. Depending upon responses he may (or may not) wish to publish a brief report in that column.

Since, for various reasons, I have not attended all of the pre-conference receptions and post-conference field trips, I shall comment only briefly upon these attractions. I have especially pleasant memories of all that I have attended. The receptions have all been enjoyable social events and have successfully fulfilled

their function of facilitating the renewal of friendships and the establishment of new ones. I have found that experiences shared in the field aid these friendships to jell.

Most members eagerly anticipate the annual Banquet. The most successful and delightful of these have featured regional or ethnic foods. Many members remember with pleasure the banquets at the conferences in, e.g., San Diego, Seattle, Boston, Mexico City, and Phoenix. Limitations of space do not permit me to enthuse over each of these. I want to comment briefly on two—Mexico City and San Diego.

The local committee in Mexico City outdid themselves in providing an array of regional dishes along with the familiar cola beverage. Since I commented earlier in these pages on the Mexico City conference (see Volume 8, No. 1) I will relate to you the memorable and unique banquet held in San Diego. The Japanese community of the city volunteered to prepare and serve a remarkable variety of Japanese foods, each dish graciously accompanied by commentary and beautiful illustrations (for sale as a benefit to the Society) of the plants and animals used in its preparation. Although only one artist executed the illustrations, many wonderful people not only donated their time but also all of the ingredients in the dishes they so lovingly prepared.

Some keynote speakers have given general addresses, i.e., not tied to a particular ethnobiological specialty, e.g., those by Darrell Posey in Riverside and Richard Nelson in Phoenix while others have had a somewhat more specific focus. Zoologists are more likely than botanists to remember the finer points of Elizabeth Wing's address in Columbia, Missouri while botanists probably remember more details than zoologists from the talks by Hugh Iltis in Norman, Oklahoma, Bruce Smith in Gainesville and Vorsila Bohrer in Albuquerque. Nor is it absolutely necessary to have a keynote speaker. There was none at the Boston Conference because, among other reasons, the banquet was prepared by the local committee in the kitchen of Lawrence and Lucy Kaplan and enjoyed in their garden. Stimulating conversation and friendly companionship replaced the customary after dinner address.

Although quite a few members have attended the Ethnobiology Conferences frequently, it appears that I am the only person to have attended all of them. Jan Timbrook and Steve Weber, for example, have been to all but two meetings. I think all of us who have attended often have felt and basked in the good will from ethnic groups when we have invited them into our lives, however briefly, through participation in our annual conferences in whatever way they can.

Sponsoring a conference is an enormous undertaking and most members of the Society are respectful of the efforts of the local committees and extremely grateful to them. It has been a pleasure for me to recall memorable moments from the past. I encourage planners of future conferences to learn about then retain as much as possible of that which has worked well in the past while continuing the tradition of taking advantage of local opportunities, thus making each conference a significant and unique event in each of our lives.

—WVA

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LOMATIUM DISSECTUM (APIACEAE): MULTI-PURPOSE PLANT OF THE PACIFIC NORTHWEST

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ABSTRACT.—The genus *Lomatium* played a key role in the *subsistence economies* of the Sahaptian and Salishan-speaking Indian peoples of the Columbia Plateau of the Pacific Northwest. *L. dissectum* (Nutt.) Math. & Const. is unusual among the *Lomatium* species of cultural significance in this area for its medicinal value, which was recognized by Native Americans throughout the species' geographic range. Its value as a fish poison was less widely recognized. Highlighting its role as a piscicide, we summarize here reports of the ethnobotanical value of this species and describe preliminary experimental results confirming its physiological activity.

RESUMEN.—El genus *Lomatium* jugó un papel clave en las *economías de subsistencia* de los indígenas hablantes de lenguas sahaptianas y salishanas de la Meseta del Columbia en la régíon del Pacífico Noroccidental de Norteamérica. *L. dissectum* (Nutt.) Math. & Const. es inusitada entre las especies culturalmente significativas de *Lomatium* en esta zona por su valor medicinal, reconocido por los indigenas americanos a lo largo de toda la distribución géografica de esta especie. Su valor como veneno para la pesca se reconocía menos ampliamente. Resumimos aquí informes del valor etnobotánico de esta especie, resaltando su papel como veneno para pescado, y sintetizamos los resultados de un experimento preliminar en laboratorio que confirma su actividad fisiológica.

RESUME.—Le genre *Lomatium* a joué un rôle clé dans les économies de subsistance des Indiens du Plateau Columbia de la région Nordouest de l'Amérique du Nord, surtout chez les peuples de groupes linguistiques Sahaptian et Salishan. *L. dissectum* (Nutt.) Math. & Const. est atypique parmis les espèces du genre en raison de ses propriétés médicinales, largement reconnues par les différentes tribus qui ont partagé son aire de distribution naturelle. Son usage en tant que poison pour se procurer des poissons consommables était beaucoup moins souvent reconnu. En soulignant ce dernier rôle, nous allons résumer ici les rapports ethnographiques qui décrivent sa valeur ethnobotanique, et nous presenterons les résultats préliminaires de nos expériences en laboratoire qui ont confirmé son efficacité pour intoxiquer des poissons.

INTRODUCTION

Hunn and French (1981) document the importance of the genus *Lomatium* Raf. (APIACEAE, or UMBELLIFERAE) in the subsistence economy of Sahaptin-speaking Indians, traditional inhabitants of the southern half of the Columbia River Plateau. Sahaptin-speakers recognize and name over a dozen species of this genus, using at least eight species as food. Turner, Bouchard, and Kennedy (1980) confirm a similar key role for this genus among the Salishan-speaking Okanagan Colville of north-central Washington and south-central British Columbia, Canada. The several species of *Lomatium* (formerly *Peucedanum)* with edible starchy, tuberous roots are known popularly as "biscuit roots;" they may also be known as "desert parsleys," indicative of their abundance in open, arid lands of western North America. We prefer the anglicized term "lomatium" as a common name. It is less well known that at least one species of the genus, *Lomatium dissectum* (Nutt.) Math. & Const., was widely used and highly regarded as a broad-spectrum medicine in Native American cultures of western North America. We summarize here published and unpublished ethnographic data on the uses of *L. dissectum* by Native American groups, then focus on its employment as a fish poison in parts of the Great Basin and southern Columbia Plateau. We present information collected by the senior authors from Sahaptin-speaking elders who participated in or observed the traditional modes of use (see also Hunn & French 1981; Hunn 1990). We also summarize the results of a laboratory study of the effects of extracts of *Lomatium dissectum* root on fish performed by the junior author (Cox 1983).

LOMATIUM DISTRIBUTION AND PATTERN OF USE IN WESTERN NORTH AMERICA

Lomatiums are well represented in the Pacific Northwest, constituting the majority of all species of the Apiaceae native to that region (Hitchcock and Cronquist 1961). The presumed genetic epicenter of this genus of some 80 species is the arid steppe of eastern Washington, Oregon, and Idaho (Mathias 1938). Lomatiums are tap-rooted perennials that flower in early spring before the arrival of intense summer heat and drought. Many species store energy in tuberous-thickened roots as an adaptation to thin soils, such as the lithosols and serpentines widespread in the Columbia Plateau and surrounding foothills (Schlessman 1980). Such species (e.g., *L. canbyi* Coult. & Rose, *L. cous* [Wats.] Coult. & Rose, *L. piperi* Coult. & Rose) are among the most important in the local Native American economies. Others were eaten as "greens" in early spring (e.g., *L. grayi* Coult. & Rose, *L. nudicaule* [Pursh] Coult. & Rose). *L. nudicaule* in particular has been shown to be a rich source of dietary ascorbic acid (Benson *et al.* 1973, Norton *et al.* 1984). Hunn (1981) has argued that the role of anadromous fish (especially salmonids) in meeting Indian food energy requirements before Euro-American contact has been exaggerated. Rather, plants harvested for their edible underground parts may have contributed on average twice as many calories as fish to Plateau Indian diets.

Although scattered ethnohistorical references to lomatiums as subsistence food and medicine exist, the scope of these plants' cultural importance appears to have been masked in part by their overt morphological similarity and the notorious taxonomic difficulty of the genus, a new species of which was discovered in Kittitas County, Washington during the 1970s (Schlessman & Constance 1979). Problems related to plant recognition are obvious in some of the accounts of early western ethnographers. Led by Kroeber and his colleagues who compiled the Culture Element Distributions, these workers were usually untrained in field botany, and their descriptions of vegetable product use by Great Basin and Plateau Native Americans—including those noting lomatium use—often lack precision and correct botanical identifications (cf. Ray 1933; 1942).

Given the morphological similarity of the lomatium species, the high degree of cognitive investment allotted to this genus by Sahaptian and Salishan-speaking peoples should be viewed as an indication of its cultural importance. Of the approximately 30 species of *Lomatium* which are found within traditional Sahaptin-speaking territory, ten folk taxa correspond precisely with scientific species while at least four others are "over-differentiated" when compared to the taxonomic treatment found in Hitchcock and Cronquist (1961). Many of these 14 named folk taxa remain well known to elderly Sahaptin speakers. They were regularly used, a number collected in truly large quantities, and several are gathered to a lesser extent today.

The new evidence we report herein lends support to the growing appreciation of the economic significance of *Lomatium* to many of the Plateau Indian groups, not only as a primary producer of food and medicine, but also as an occasional indirect procurer of animal protein. We focus here on one species of exceptional cultural significance, *L. dissectum*. The uses reported for this species are summarized in Table 1. Its application by Sahaptin speakers to stupefy freshwater fish for human consumption (usually trout—*Salmo* spp., but probably also redside shiner—*Richardsonius balteatus*—and other Cyprinidae), is described. Preliminary experimental work undertaken to identify its piscicidal properties is presented.

RANGE AND CULTURAL ROLE OF *LOMATIUM DISSECTUM*

L. dissectum ranges from Vancouver Island, British Columbia, east to Alberta and western Montana, and south to Colorado, New Mexico, Nevada and interior southern California (Jepson 1936). It can be found from sea level to elevations over 2500 m mostly in dry rocky slopes, meadows and talus. Despite the recognition of three geographical populations by Hitchcock and Cronquist (1961:551), subspecific distinctions are not recognized by Sahaptin speakers, nor, as far as we can tell, are they made in other Native American languages. The plant, shown in Figure 1, is variously known in English as "toza root," "cough root," "chocolate tips," and "Indian balsam."

L. dissectum has been widely used by American Indians in human and veterinary medicine, administered both internally and externally. It has been less widely employed as food, the young shoots consumed raw as a green vegetable (Murphey 1959; Turner 1978; Turner *et al.* 1980) or the roots eaten (Steedman 1930; Turner 1978; Turner *et al.* n.d.).

Table 1.—Aboriginal names and uses[1] of *L. dissectum* throughout its geographic range. Syns. *Leptotaenia dissecta* Nutt. in T. & G., *Ferula dissecta* Gray, *Lept. multifida* Nutt. in T. & G., *Ferula multifida* Gray, *Lept. dissecta* var. *multifida* Jeps., *Lomatium dissectum* var. *multifidum* Math. & Const., *Lept. dissecta* var. *foliosa* Hook., *Lept. foliosa* Coult. & Rose, *Lept. eatoni* Coult. & Rose, *Lept. multifida* var. *eatoni* M.E. Jones (Hitchcock & Cronquist 1961(3):551).

Native area/group	Term	Use	Source
I. Columbia Plateau			
A. Salishan languages			
1. Shuswap	gayú=the plant; sewayá=the young "tops"	young root as food, roasted and eaten; old root as medicine for sores	Palmer 1975
		older shoots and roots of young plants eaten	Turner 1978
2. Thompson	təx=qin (="chocolate tips," *L. dissectum)*	root eaten; as medicine in infusion for colds and asthma, to soak broken limbs, dried and crushed roots on wounds, sores, boils; dog and horse medicine for sores	Turner 1978 Turner *et al.* n.d.
Thompson	taxqái•n (=*Lept. dissecta)*	root dried, cooked when needed, used as horse and dog medicine, root dried, crushed, sprinkled on wounds	Steedman 1930
Thompson	taxqáin (=*Ferula dissoluta)*	roots for food	Teit 1930
3. Okanagan-Colville			
a) Okanagan-Colville	gayu? (=*L. dissectum)* shoots called sewiya?; called "chocolate tips" in English	roots to poison fish; young shoots gathered as they break ground (early March) and eaten, inedible later; mature tops rubbed on cattle to kill lice; fish poison solution poured on	Turner *et al.* 1980

		horses/cattle to kill vermin; roots used as poultice for sores, cuts, boils, bruises; to cure dandruff	
Okanagan-Colville	ai•yú		Steedman 1930
b) Okanagan	ai•yú (=*Ferula dissoluta)*	roots for food	Teit 1930
c) S. Okanagan (Sinkaietk)	cwaya=term used by Spier to apply to the entire plant; but acc. to Turner 1978=the young shoots only	famine food	Turner 1978 Turner *et al.* 1980 (citing Spier 1938)
d) Sanpoil-Nespelem	ayu^{s}, ai'u, a'yu' (="Balsam root *[Osmorhiza* sp.] .. id not certain ..)	as food; for sores, wounds, bruises, boils, general illness; for easing horses	Ray 1933
Sanpoil	*L. dissectum*	"First roots" ceremony	Turner *et al.* 1980
e) Lakes	*L. dissectum*	roots used to make a steam bath for rheumatism, sprains, pneumonia	Turner *et al.* 1980
4. Columbia-Wenatchi	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942
B. Sahaptian languages			
1. Sahaptin			
a) Northwest dialects			
1) Klikitat	čalúkš	suffocate fish; topical application for sores, crippled arm, dandruff, psoriasis; infusion drunk against colds	
Klikitat	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942

Table 1.—Aboriginal names and uses[1] of *L. dissectum* throughout its geographic range. Syns. *Leptotaenia dissecta* Nutt. in T. & G., *Ferula dissecta* Gray, *Lept. multifida* Nutt. in T. & G., *Ferula multifida* Gray, *Lept. dissecta* var. *multifida* Jeps., *Lomatium dissectum* var. *multifidum* Math. & Const., *Lept. dissecta* var. *foliosa* Hook., *Lept. foliosa* Coult. & Rose, *Lept. eatoni* Coult. & Rose, *Lept. multifida* var. *eatoni* M.E. Jones (Hitchcock & Cronquist 1961(3):551). (Continued)

Native area/group	Term	Use	Source
2) Yakima	čalúkš	horse medicine; fish poison; drank infusion of root for colds, tuberculosis	
3) Kittitas	(unspecified plant, probably *L. dissectum)*	fish poison	Ray 1942
b) N.E. dialects			
1) Snake River	čalúkš	kill fish; topical application for sores; whiten hides	
c) Columbia R. dialects			
1) Umatilla	čalúkš (=*L. dissectum* var. *multifidum)*	fish poison; medicinal; not eaten	
2) John Day River	čalúkš (=*L. dissectum* var. *multifidum)*	fish poison; topical application for wounds, boils, saddle sores; infusion drunk for colds, flu; inhalant to strengthen horses; root as ball in stick game; not eaten	Hunn & French 1981
3) Rock Creek	čalúkš (=*L. dissectum* var. *multifidum)*	medicine for dandruff	
4) Tenino	"sunflower root" (probably *L. dissectum)*	fish poison	Ray 1942
5) Warm Springs dialects (Celilo,	čalúkš (=*L. dissectum* var. *multifidum)*	for tanning rawhide (deer); human and horse medicine; tick wash in	French (pers. comm.), Cox 1983

Tenino-Tygh)		spring; infusion for sick horses who are also made to inhale smoke; cure for distemper; hair wash for humans, to remove ticks, lice, to cure dandruff; in infusion for fever; chewed while sweating; sprouts eaten	
6) unspecified Warm Springs	cha-luksch (=*Lept. multifida* syn. *L. dissectum* var. *multifidum* or "Indian Balsam")	tea made for coughs or flu from root chips; external wash for dandruff, to rid horses of ticks; root for tanning hides	Murphey 1959
2. Nez Perce	titalam (=*L. dissectum*); upper root called i•cus	famine food; upper root considered too oily to be eaten; gathered when necessary in Jan./Feb.	Marshall 1977
Nez Perce	*L. dissectum*	roots eaten, baked underground for 1 or 2 days; root is medicine: oil rubbed on sores, sore eyes; root mixed with tobacco and smoked for sinus trouble; drunk as tea to cure tuberculosis or increase appetite	Hart 1976
C. Chinookan languages			
1. Upper chinookan			
a) Wasco-Wishram/ Cascades	a-gə́x+gəx a-gáx+gax (=*L. dissectum* var. *multifidum*)	for horse grooming and medicine (especially race horses); for sores and wire cuts on horses. . . for similar things on humans; for head lice; for preparing deer hides; to stupefy fish	French (pers. comm.)
II. Great Plains			
A. Algonquian languages			

Table 1.—Aboriginal names and uses[1] of *L. dissectum* throughout its geographic range. Syns. *Leptotaenia dissecta* Nutt. in T. & G., *Ferula dissecta* Gray, *Lept. multifida* Nutt. in T. & G., *Ferula multifida* Gray, *Lept. dissecta* var. *multifida* Jeps., *Lomatium dissectum* var. *multifidum* Math. & Const., *Lept. dissecta* var. *foliosa* Hook., *Lept. foliosa* Coult. & Rose, *Lept. eatoni* Coult. & Rose, *Lept. multifida* var. *eatoni* M.E. Jones (Hitchcock & Cronquist 1961(3):551). (Continued)

Native area/group	Term	Use	Source
1. Blackfoot	o-muck-kas (=*L. dissectum* var. *multifidum*)	horse medicine and magic; gathered in fall; tonic for humans	Johnston 1970 (citing McClintock 1910 & Ewers 1955)
Blackfoot	"big turnip" (=*L. dissectum*)	medicine for horse fertility; as inhalant for distemper in horses	Hellson & Gadd 1974 (citing Ewers 1955)
Blackfoot	"big turnip" (=*Lept. multifida*)	for colic and distemper in horses; as fertility/growth amulet for horses	Ewers 1955
2. Arapaho	nee-a-tat (=*Lept. multifida*)	see Wind River Shoshone below	Nickerson 1966
B. Siouan languages			
1. Crow	isé (=*Lept. multifida* or "bear root")	incense in sweat lodge; medicine for children to make them grow straight; cure-all: chewed for colds, tooth ache, used as liniment on sores	Lowie 1935
III. Great Basin/ California	*L. dissectum* ("fern-leaved lomatium")	semi-sacred cure-all; still in common use in 1980s	Fowler 1986
A. Numic languages			
1. N. Paiute	tóza (=*Lept. dissecta* var. *multifida*)	roots pounded and soaked in water or smoke from smudge fire fanned over water to stupefy fish; root smoked or chewed to cure colds	Stewart 1941

a) unspecified "Paiute"	toza (=*Lept. multifida*)	see Murphey entry for Shoshone	Murphey 1959
unspecified "Paiute"	*toh*-aw-sav-ve, *toh*-sah, *toh*-sah-*ah*, *toh*-sup	see Train *et al.* entry for Shoshone	Train *et al.* 1957
2. Shoshone			
a) unspecified	toza (=*Lept. multifida*)	stalks eaten in spring; tea made for coughs or flu and as a tonic (from root chips); "Ruby Valley Shoshone cut fresh root. . . drop of oil in each eye of a trachoma sufferer. . . "; for distemper in horses, force them to inhale smoke of root; ground root powder for saddle sores; wash of root to get rid of ticks, and for dandruff	Murphey 1959
unspecified	*toh*-aw-sa-ve, *toh*-sah, *toh*-sup (=*Lept. multifida*)	panacea: coughs/colds, hayfever, bronchitis, pneumonia, tuberculosis, prepared as tea but smoked, or chewed for sore throat; external washes against smallpox, skin rashes, sores, or as poultice; drops of oily juice on skin problems, as eye drops for trachoma or gonorrheal infections; fresh root ground and applied to newly cut umbilical cord; root in poultice for swelling, sprains, rheumatism; root to cure horse distemper (horse exercised then made to inhale fumes from burning root)	Train *et al.* 1957
unspecified	tootsa (=*L. dissectum* var. *multifidum*)	important medicine for humans and animals; root collected in summer, cut	Smith 1972

Table 1.—Aboriginal names and uses[1] of *L. dissectum* throughout its geographic range. Syns. *Leptotaenia dissecta* Nutt. in T. & G., *Ferula dissecta* Gray, *Lept. multifida* Nutt. in T. & G., *Ferula multifida* Gray, *Lept. dissecta* var. *multifida* Jeps., *Lomatium dissectum* var. *multifidum* Math. & Const., *Lept. dissecta* var. *foliosa* Hook., *Lept. foliosa* Coult. & Rose, *Lept. eatoni* Coult. & Rose, *Lept. multifida* var. *eatoni* M.E. Jones (Hitchcock & Cronquist 1961(3):551). (Continued)

Native area/group	Term	Use	Source
		and dried for colds/flu as a tea; ground root mixed with tobacco and smoked for head and lung congestion; root placed in nostrils for headache; root steeped in hot water for rheumatic pain; external washes prepared for dandruff and skin abrasions	
b) Nevada Shoshone	tatsip, tooza, to:dza	fish poison, leaf smoked	Steward 1941
c) Wind River or E. Shoshone	*Lept. multifida*	root eaten, raw or cooked; young shoots cooked and eaten; dried root chips added to ''Bull Durham'' for friendly smoke; water boiled with root to sponge off a sick person; dry root pounded with grease for massage of affected parts; root boiled into decoction for colds/flu; steam likewise inhaled	Nickerson 1966
d) Gosiute	tó-dzûp (=*Ferula multifida*)	young shoots and seeds eaten; smoke from root inhaled for horse distemper; smashed root applied to wounds, cuts, bruises, broken bones. . . ''most valued (of) medicines''	Chamberlin 1911

3. unspecified Nevada Indians	toza (=*Lept. multifida*)	"big medicine": powdered for use on sores; a tea drunk for coughs and as a tonic; chips burned, smoke inhaled for asthma or bronchial problems	Nickerson 1966
4. S. Paiute			
a) "Ute"	tó-dzûp (=*Ferula multifida*)	remedy for horse distemper: smoke from burning root inhaled	Chamberlin 1911
b) Uinta Ute	tó-tûv (=*Ferula multifida*)	"highly valued medicine", applied externally on wounds; smoke of pulverized root inhaled by horse against distemper	Chamberlin 1909
B. Hokan languages			
1. Atsugewi (Pit River)	*Lept. multifida*	to poison fish	Stewart 1941
Atsugewi (Pit River)	"wild parsley" (*Ligusticum grayi* Coult. & Rose, id felt to be uncertain by author) = bóhom (poss. *L. dissectum*)	to poison fish; eaten in spring when tender; remedy for colds/flu/cough, children's stomach ache; root either chewed or prepared in infusion	Garth 1953
2. Washoe	*d*osa, *d*oza	same as Train *et al.* 1957 for Shoshone	Train *et al.* 1957
Washoe	doza	tea for cough/flu from root chips	Murphey 1959
Washoe (incl. Atsa)	toza (=*Lept. multifida* = "Ind. balsam")	fish poison; smoked and chewed to cure cold	Stewart 1941
3. Karok	coma'ish (=*L. dissectum*)		Constance n.d.

The clearest reference to the plant's use as "fish poison" has been, until recently, from Northern Paiute bands in the western Great Basin (Stewart 1941: 425). Only within the last ten years has its use in the Plateau as a fish stupefacient been documented in detail. Investigations among Salishan-speaking Okanagan-Colville (Turner *et al.* 1980) and Sahaptin-speaking Yakima and John Day River Indians (Hunn 1990) show clearly that its use in capturing fish is not

FIG. 1.—*Lomatium dissectum* in its natural habitat. Photo by N.J. Turner.

restricted to the Great Basin. On the strength of these ethnographic reports we may conclude that *L. dissectum* was the unidentified fish poison Ray (1942:114) ascribed to Wenatchi, Kittitas, Tenino, and Klikitat Indians.

Citing Rostlund's (1952) monograph on aboriginal fishing—which relies on Ray's testimony—Cressman (1977:118) asserted that "limited use [of unspecified fish poisons] is reported for the Columbia Plateau in the area of tributary streams running to the Columbia River from the eastern flanks of the Cascade Mountains. It [fish poison use] is absent in the rest of the Far West." He indirectly attributes the absence of fish poison use to the presence of the leister spear, a two or three pronged thrusting instrument suitable to freshwater spear fishing. According to Cressman " . . . The two methods are mutually exclusive" (1977:115). The fact that *L. dissectum* was widely used to stupefy fish by Columbia Plateau Indians—who also employed the leister spear—belies Cressman's conclusion. The two methods, in fact, complement one another, each appropriate to different settings: poisoning to small, quiet streams in the mountains, the leister spear to the deep waters of bigger rivers. The absence of large rivers in the Great Basin seems a more likely explanation for the leister spear's limited distribution south of the Columbia River than the presumed "blocking" action attributed by Cressman to fish poisons.

ETHNOGRAPHIC ACCOUNTS OF THE USE OF *LOMATIUM DISSECTUM* AS A FISH POISON IN THE PLATEAU

The following information on *L. dissectum* use is based on interviews with nine native Sahaptin-speaking elders (born between 1911 and 1923) representing all three major dialect groups of the Sahaptin language. All referred to the plant as *čalúkš* (etymology uncertain, perhaps *ča-* [= "pull, as with the teeth or mouth"] + *lúkš* [= Columbia River dialect term for *Lomatium canbyi]).* Four of these consultants positively identified voucher specimens of *L. dissectum* as *čalúkš* (Hunn 270840, 270886, 270899, WTU). Two other consultants regularly identified the species *in situ* as such. Individuals of both locally occurring varieties, *L. d. dissectum* and *L. d. multifidum* (Nutt.) Math. & Const., as well as individuals of yellow and dark purple petaled populations, were named *čalúkš* without distinction. No special terms were recorded for either the shoots or root crown, as has been noted elsewhere (Table 1). According to our consultants, *L. dissectum* was commonly employed to harvest fish at the following sites: Moses Coulee, Douglas Co., WA.; Little Klickitat River, Klickitat Co., WA.; Logy Creek, Yakima Co., WA.; and around the headwaters of the John Day and Umatilla Rivers in Oregon. Our information accords well with that for the Okanagan-Colville reported by Turner *et al.* (1980:66). French's Warm Springs Sahaptin consultants have denied the use of *L. dissectum* as a fish poison, though Ray (1942:114) attributes to the Tenino the use of "macerated sunflower" root to poison trout *(Salmo* spp.) and whitefish *(Prosopium* spp.).

In April and May when root-digging began in earnest for Native Americans living in the southern Columbia Plateau, small groups of people moved away from the river into the upper Sonoran and transition vegetation zones to well-

known root-digging areas, while others stayed at the river to harvest the spring Chinook salmon run (Hunn 1990). Those moving into the foothills followed a round which ensured continual correspondence between labor availability and plant maturation in response to elevation and other factors. Large quantities of *Lomatium* and *Lewisia* (bitterroot) roots were harvested and dried for winter consumption.

While away from the Columbia River and their usual salmon protein source in late spring and summer, root-digging groups used *L. dissectum* opportunistically to stupefy smaller non-anadromous fish for immediate consumption. According to James Selam, a John Day River elder (born 1919), securing the root was not difficult. The plant is widespread and commonly found on rocky slopes and in talus adjacent to streams. According to Mr. Selam this apparent fortuitous coincidence was not coincidence at all. He remarked that ''the Maker must have put it *[L. dissectum]* there for the fisherman.'' The roots were extracted with the digging stick, the tool of choice for harvesting bitterroot and edible tuberous lomatiums. The roots were then placed in a burlap sack and mashed with the hands or a rock. The sack was then placed in a slow moving section of stream, the greater the water volume the more roots used. Two or three roots would normally suffice, but up to ten might be needed for a particularly large pool. When fish started to float to the surface, the sack was pulled out and the larger fish gathered up. The remaining fish, according to our consultants, would revive once the sack was removed and clear water allowed to flow through. The effect of the poison on the fish was likened to them ''getting drunk'' or being ''knocked out.'' Streams were apparently not dammed for this purpose, perhaps because, as Mr. Selam claims, one should use *L. dissectum* only in flowing water or ''you will kill all the fish.'' A second method was reported by Gilbert Smartlowit, a Yakima Indian of Upper Cowlitz extraction (born 1911), describing a Klikitat Indian practice. The roots were boiled and the water then poured into the stream or pool with the same result. The harvested fish were strung on a willow twig for transport back to camp where they were cooked and eaten.

Despite these detailed accounts, Hunn was unable to replicate the ethnographic fish poisoning technique of Selam on 21 March, 1979. According to Mr. Selam, the target species of fish poisoning, trout *(Salmo gairdneri, S. clarki),* were absent from mountain streams before late May or June because of low water temperatures. Furthermore, it is possible that *L. dissectum* roots lose potency in the winter. Mr. Selam suggested these as the reasons for the failure of Hunn's experimental effort.

Protein derived from such freshwater fish was clearly secondary to that contributed to the native diet by salmon fishing and deer hunting. However, it should not be overlooked in a comprehensive description of native subsistence. It served as an efficient way of securing needed protein in areas where other sources might not have been readily available.

BIOCHEMICAL STUDIES OF *LOMATIUM DISSECTUM* AS A FISH POISON

The exact nature of the fish-stupefying mechanism in *L. dissectum* is unknown. However, we have been able to verify anthropological reports regarding the

piscicidal property of this species through an experiment in which samples of dried and ground *L. dissectum* root were placed in small water-filled tanks occupied by coho salmon *(Oncorhynchus kisutch)*[2]. In addition, chemical extractions of *L. dissectum* root coupled with bioassays using coho salmon allowed us to investigate the molecular composition of the plant's ichthyotoxic ingredient(s). We also present data from sodium uptake experiments as a first attempt to characterize the physiological effect of the plant on fish.

In our preliminary set of experiments, samples of dried root were administered to fingerling salmon which ranged in weight from 3–20 g. The L.D.-50 was established at 0.20 g/l (dried root/water). At first the fish were hyperactive, exhibiting sudden bursts of energy, jumping from the water, displaying overactive gill motion, and frequently hitting themselves against the sides of the holding tank. Subsequently, they would slow, begin to lose equilibrium, float belly up, and sometimes begin to sink. The same fish might repeat this contrasting pattern three or four times within one minute.

Once anthropological reports on the ichthyotoxic effect of *L. dissectum* were successfully verified, organic separations were carried out on the root of the plant with the intention of identifying a toxic fraction. Extracts—both organic and water soluble—were assayed for activity using fingerling salmon. Those fractions showing the most toxicity were subjected to chemical identification by two dimensional paper chromatography and ultra-violet spectroscopy.

At the time of our experiments, previous extraction procedures undertaken on *L. dissectum* and related species were known to have isolated ichthyotoxic furanocoumarin molescules (Gupta & Soine 1964; Lloyd & Jenkins 1942). The furanocoumarin peucedanin, isolated as the active ingredient from *Peucedanum officinale* L. (Apiaceae), had been shown to kill fish (Murray *et al.* 1982:2). The roots of the umbelliferous species *Pteryxia terebinthina* Coult. & Rose (= *Cymopterus terebinthinus* [Hook] T. & G.), produced a crystaline substance known as pteryxin which showed toxicity to fish. Chemical analysis indicated that this activity was probably due to a benzopyrone (Call & Fischer 1958; Thompson *et al.* 1979).

In light of these studies, we chose to follow an extraction scheme designed to isolate coumarin-like moities. Among the several separation procedures attempted, those designed after the scheme employed by Steck (1973) produced the most toxic fraction. This extract showed general coumarin-like properties such as sweet ''fresh mown hay'' scent, blue flourescence under UV light, and Rf values of 0.82, 0.78–0.77. A UV absorption analysis revealed the following (in EtOH): a λ maximum at 325 nm, A = 0.93; a λ maximum at 255 nm and 247 nm, A = 0.37, and a λ minimum at 261 nm, A = 0.20. These values correspond to the known UV absorption spectrum of coumarins isolated from Apiaceae for which specific molecular configurations have been determined (Nielson & Jensen 1976; Smith *et al.* 1957; Steck 1973; Willette & Soine 1962; 1964). Figure 2 illustrates, for comparison, the UV absorption bands of the toxic fraction isolated here from *L. dissectum* with those for two previously isolated furanocoumarins, columbianetin (a) from *L. dissectum* and suksdorfin (b) from *L. suksdorfii* (Wats.) Coult. & Rose (Willette & Soine 1962; 1964). These bands closely correspond to the absorption data obtained here for the toxic fraction derived from *L. dissectum* roots. This suggested that the major components of our *L. dissectum* toxic fraction were furanocoumarin-like molecules.

Subsequent to our experiments, others have shown that coumarin glycosides are indeed major components of the organic fraction of *L. dissectum* root (Van Wagenen *et al.* 1988). However, despite their presence in *L. dissectum,* such compounds were not found to be toxic to fish by these workers (1988:139). Rather, VanWagenen *et al.* claim that the piscicidal action is caused by unrelated tetronic acid molecules. These were found in *L. dissectum* to be unstable and in low abundance. Based on the description in VanWagenen *et al.* (1988), we feel it is possible that tetronic acids co-migrated with our coumarin components and were

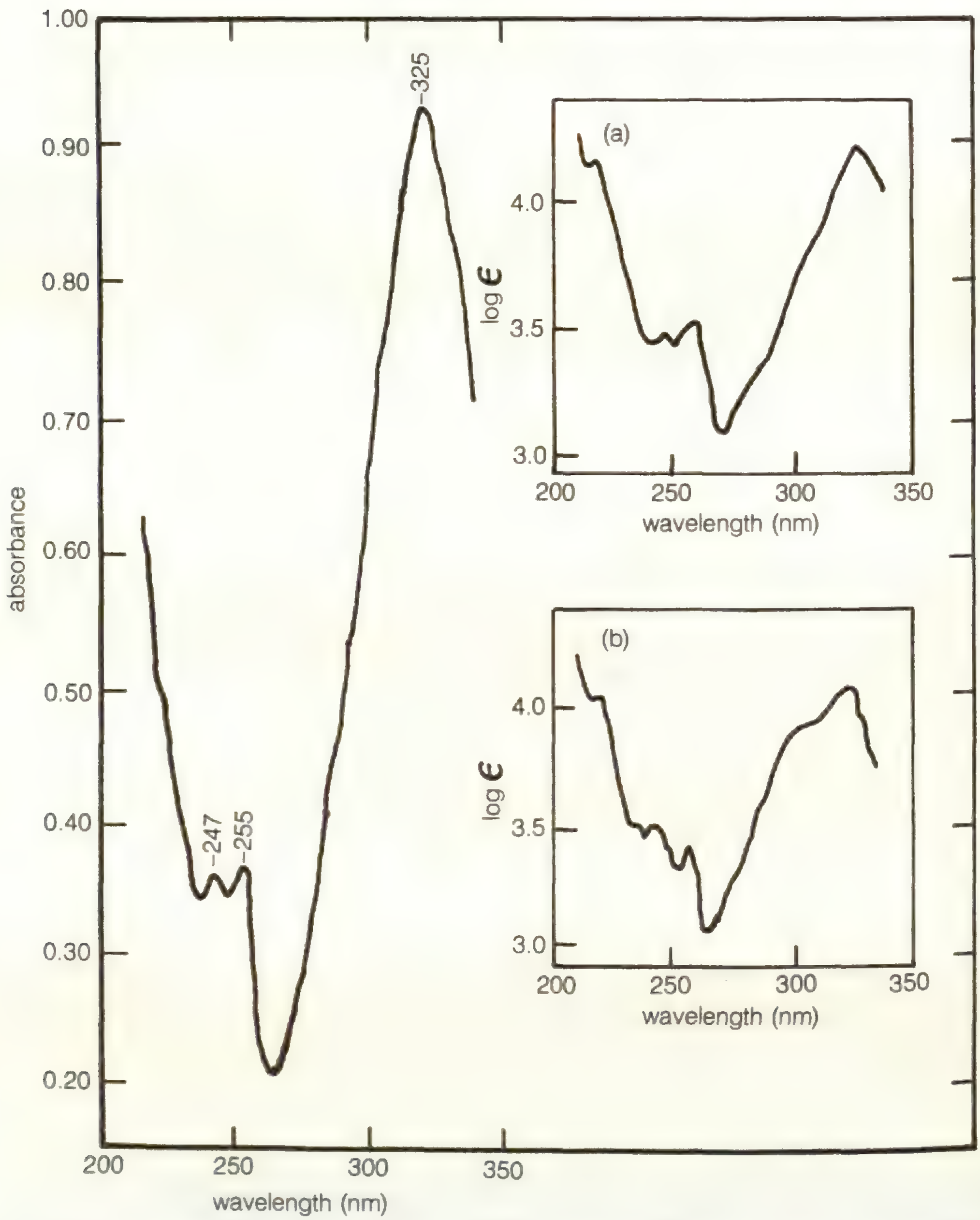

FIG. 2.—UV absorption spectrum for toxic fraction of *L. dissectum.* Insets show (a) UV spectrum for columbianetin (taken from Willette & Soine 1964), (b) UV spectrum for suksdorfin (taken from Willette & Soine 1962).

present in such low quantities that they went unrecognized in the toxic fraction generated by our extraction procedures.

In spite of the recent findings of VanWagenen *et al.*, the exact piscicidal mode of action of *L. dissectum* root remains to be characterized. We undertook preliminary experiments in an attempt to do this. One hundred sixty salmon fingerlings were equally distributed between two baths, each bath containing equal doses of radioactively labelled sodium. One bath contained a homogenate of the dried root. Every half hour for seven hours, four fish were removed from each bath and whole body sodium content was counted. As shown in Figure 3, fish in the *L. dissectum* bath proved to be consistently lower in sodium levels, sug-

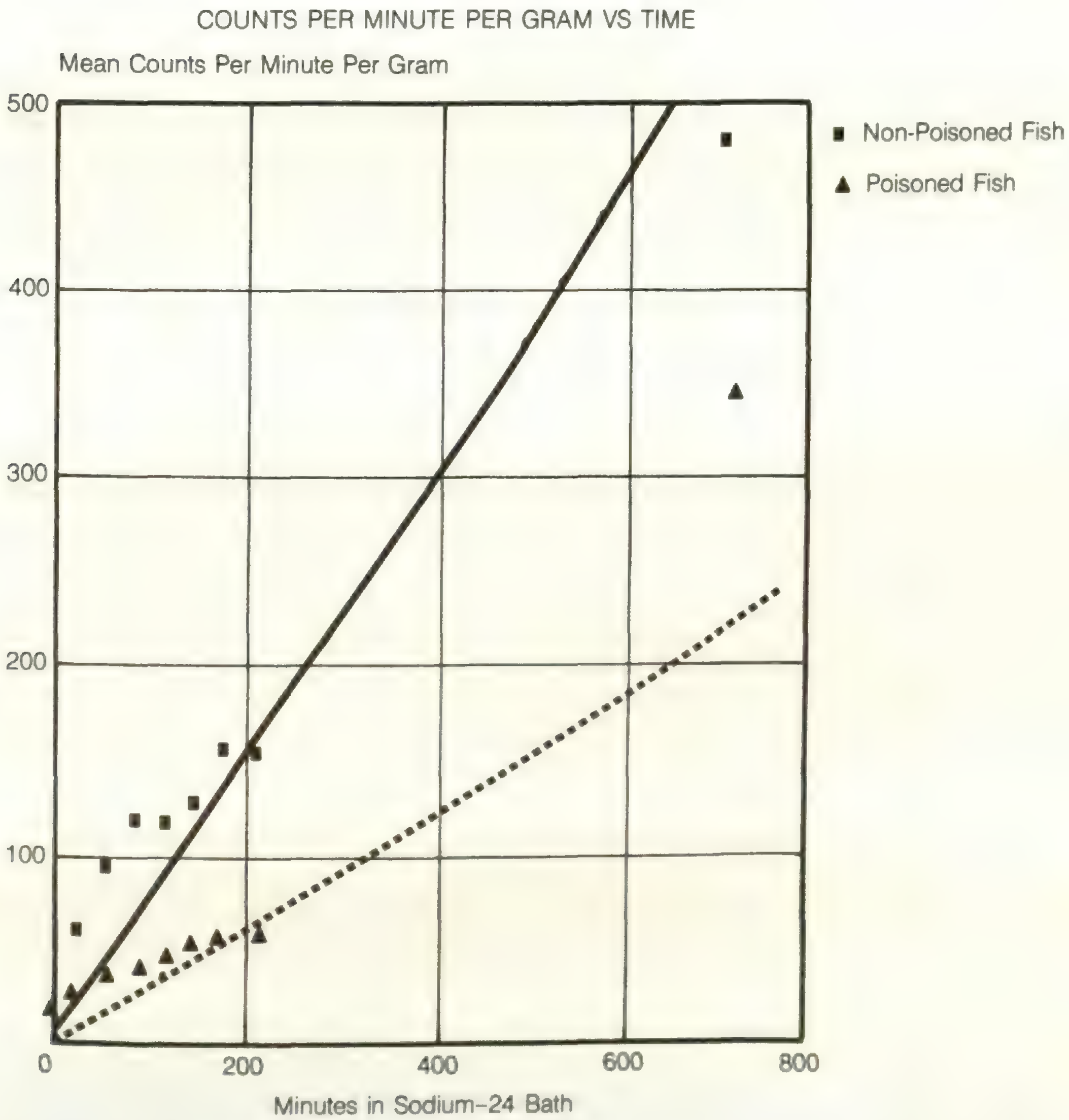

FIG. 3.—Sodium uptake in poisoned and non-poisoned salmon fingerlings.

gesting that affected fish were experiencing inhibition of sodium uptake at the gills. This indicated a possible broad spectrum inhibition of molecular uptake at the gills including, among other things, reduced oxygen transfer.

While the results of our UV absorption and paper chromatography tests performed on the toxic fractions of *L. dissectum* root suggested that furanocoumarin- or coumarin-like molecules made up a majority of the chemical mixture, and were possibly the piscicidal agents somehow affecting sodium uptake, others have claimed that ichthyotoxicity is due to small, unstable quantities of tetronic acids (VanWagenen *et al.* 1988). In light of our findings and of the several earlier studies demonstrating toxicity of coumarins to fish, we hope that further experiments, generating detailed bioassay data, will be forthcoming for this interesting plant.

CONCLUSIONS

While it has been shown recently that lomatiums have made significant if not primary contributions to the diet of Sahaptin-speaking Plateau Indians, it seems increasingly that their cultural contribution was and remains highly elaborate and multidimensional, as the *L. dissectum* example above demonstrates. Fully more than one-third of the species occurring in the traditional Sahaptin range were named and used. The remarkable correspondence between cultural focus and folk systematic differentiation within this taxonomically difficult genus is demonstrated not only by the widespread medicinal use of lomatiums, but by their nutritional contributions in terms of carbohydrates, vitamins, minerals and, indirectly, protein through fish incapacitation.

ACKNOWLEDGEMENTS

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NOTES

[1]The orthography follows that found in the published sources. Where no source is provided, the data is from Hunn's field notes.

[2]Plant material used for both bioassays and chemical extractions was collected on the north side of the Columbia River, about 3 miles east of Bingen, WA. A voucher specimen of this plant material (No. 4579), identified as *L. dissectum* var. *dissectum,* has been placed in the herbarium at the Reed College Biology Department.

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Because of lack of time and other complications, Associate Editor Alejandro de Avilla B. was not able to check the translations of the abstracts of articles which appeared in Volume 9, Number 1 of the *Journal of Ethnobiology*. He has generously submitted translations of these abstracts which are more faithful to the English than those that appeared with the articles themselves. We regret that these improved translations could not be published earlier and we are pleased to do so now.

Because checking translations into other languages requires time (a great deal of time in the mails), we must request that prospective contributors to the *Journal* have their translations prepared as soon as possible so that the best possible rendering of abstracts into Spanish and French can appear simultaneously with the published article. (If need be, we will accept manuscripts without translations.)

—W. Van Asdall, K.R. Adams, A. de Avila B.

Balee, William. **NOMENCLATURAL PATTERNS IN KA'APOR ETHNOBOTANY.**

RESUMEN.—Una larga historia de horticultura parece haber afectado la nomenclatura de las plantas en Ka'apor y otras lenguas de la familia Tupi-Guarani, habladas en las tierras bajas de Sudamérica. La lengua Ka'apor muestra ciertos patrones para la construccíon de lexemas primarios productivos e improductivos que se refieren a plantas. Dichos lexemas aparecen en cerca de un tercio de todos los nombres genéricos de plantas en Ka'apor. Cinco de los patrones de nomenclatura relacionados con estos lexemas distinguen a los nombres de las plantas tradicionalmente cultivadas de los nombres de plantas no cultivadas. Esto patrones obedecen a una norma subyacente: los lexemas primarios productivos e improductivos en la etnobotánica Ka'apor se refieren a plantas no cultivadas tradicionalmente.

McDonald, Darrel L. **A SURVEY OF PUBLIC PLANTINGS IN THE FRONT YARDS OF RESIDENCES IN GALVESTON, TEXAS, U.S.A.**

RESUMEN.—Los paisajes cultivados (vegetación plantada) de la Ciudad de Galveston son consecuencia de eventos históricos, de introducciones de plantas, y de modificaciones del medio ambiente. Desde que Galveston se constituyó en 1837, sus residentes han alterado y esculpido continuamente los terrenos publicos y privados. Este estudio identifica importantes especies nativas e introducciones de plantas que han dado lugar a jardines de corte tropical y europeo. Varias plantas exoticas introducidas en el siglo XIX. como adelfas (*Nerium oleander* L.), palmas (*Washingtonia* spp. y *Phoenix* spp.), y árboles de sebo de China (*Sapium sebriferum* (L.) Roxb.) siguen siendo especies preferidas, si bien nuevas plantas continuan siendo introducidas. Por la intervención humana, un paisaje cultivado mas colorido ha reemplazado a las comunidades de plantas nativas de la costa del Golfo de México, reflejando preferencias individuales, comunitarias e institucionales. La investigación sugiere también que cambios en el estilo de vida de los residentes han influido sobre el diseño de los sembrados en los jardines residenciales.

Ehrlich, Celia. **SPECIAL PROBLEMS IN AN ETHNOBOTANICAL LITERATURE SEARCH: *CORDYLINE TERMINALS* (L.) KUNTH, THE "HAWAIIAN TI PLANT"**

RESUMEN.—Los diferentes tipos de referencias acerca de plantas que hacen los botánicos, los etnógrafos y los lingüistas pueden confundir a etnobotánicos que intentan rastrear ciertas especies a través de la literatura. Los cambios en la nomenclatura botánica, el uso de nombres locales y comunes poco conocidos, y la distinción insuficiente entre variedades ocasionan dificultades para los investigadores que buscan referencias a plantas particulares. Los problemas encontrados en una investigación de *Cordyline terminalis* (L.) Kunth, la "planta ti hawaiiana," ilustran estas dificultades e indican algunas formas de superarlas.

Turner, Nancy J. **"ALL BERRIES HAVE RELATIONS" MID-RANGE FOLK PLANT GROUPINGS IN THOMPSON AND LILLOOET INTERIOR SALISH**

RESUMEN.—Un total de 79 agrupaciones diversas de plantas a nivel medio (tal y como son agrupadas las plantas en las clasificaciones indígenas) en Thompson y 38 agrupaciones en Lillooet, dos grupos de lenguas del Salish Interior de Columbia Británica, se inventarián y discuten dentro del contexto de los "taxa intermedios," definidos por Berlin, Breedlove y Raven (1973) en sus Principios Generales de la biología "folk." Estas agrupaciones de nivel medio se aplican en forma más restringida que las categoriás generales de "forma de vida," pero son más amplias y más inclusivas que los taxa básicos del nivel de "género" que se refieren a tipos perceptualmente distintos de plantas. Entre Thompson y Lillooet, y entre éstos y otros grupos indígenas estudiados del noroeste de Norteamérica, las agrupaciones de nivel medio muestran semejanzas en sus cualidades y en sus dimensiones.

Algunas calificarían como verdaderos taxa "intermedios" en el sentido de Berlin y sus colaboradores, pero muchas se definen primordialmente por características utilitarias o con fines especiales, y se relacionan por afiliación en vez de relacionarse por inclusión. Algunas se traslapan, tanto entre ellas mismas como en referencia a las clases generales que se les sobreponen. Algunas contienen miembros que, aunque son perceptualmente distintos, no se nombran a un nivel más restringido. Esto es especialmente cierto para plantas de baja significación cultural. Algunas de las agrupaciones de nivel medio muestran evidencias de expansión reciente o de alteración semántica para acomodar a nuevas plantas y productos vegetales a raíz del contacto entre las culturas indigenas y europeas.

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"DOMESTICATION" OF HYRAX *(PROCAVIA CAPENSIS),* IN YEMEN

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ABSTRACT.—A case of attempted small mammal "domestication" is described based on ethnographic data from the Yemen Arab Republic (Fig. 1). Households of low economic status sought to supplement their cash incomes by taming a previously hunted species, the hyrax, *Procavia capensis jayakari.* The experiments have largely ended in failure due to factors including the animal's biology and a poor management strategy. This episode is placed in the context of animal-impact and human-impact models of domestication.

RESUMEN.—En base a datos etnográficos de la Republica Arabe Yemenita, se describe un caso de intento de "domesticación" de un mamifero pequeño. Unidades domésticas de condición económica baja trataron de suplementar sus ingresos monetarios amansando una especie que anteriormente era cazada, el hirax, *Procavia capensis jayakari.* Los experimentos en gran parte han terminado en el fracaso debido a factores que incluyen la biología del animal y una mala estrategia de manejo. Este episodio es ubicado dentro del contexto de modelos de domesticación de impacto animal y de impacto humano.

RESUME.—On decrit un cas de domestication essayee de mammiferes petits selon l'information ethnographique de la Republique Arabe de Yemen. Les maisonees du rang economique bas cherchaient a ajouter a sus revenus par apprivoiser a une espece anterieusement chassee, le damans, *Procavia capensis jayakari.* Les experiments ont principalement echoue par suite de la biologie de l'animal et d'une strategie de direction mauvaise. On place cet episode dans le contexte des modeles de la domestication de l'impact des animaux et de l'impact de l'homme.

INTRODUCTION

The list of small mammals for which there is a record of husbandry by traditional societies is relatively short. It includes such species as the cavy and perhaps the chinchilla in western South America, the rabbit and dormouse in Europe and the Mediterranean, the cane rat in Africa, and a scattering of others. Thus the discovery of a new "domesticate," the hyrax *(Procavia capensis jayakari),* in Yemen

(Fig. 1) is somewhat of an event. This report is of additional interest because this attempt at husbandry appears to be an indigenous event and thus can be used to test a model of how the process of small animal domestication occurs.

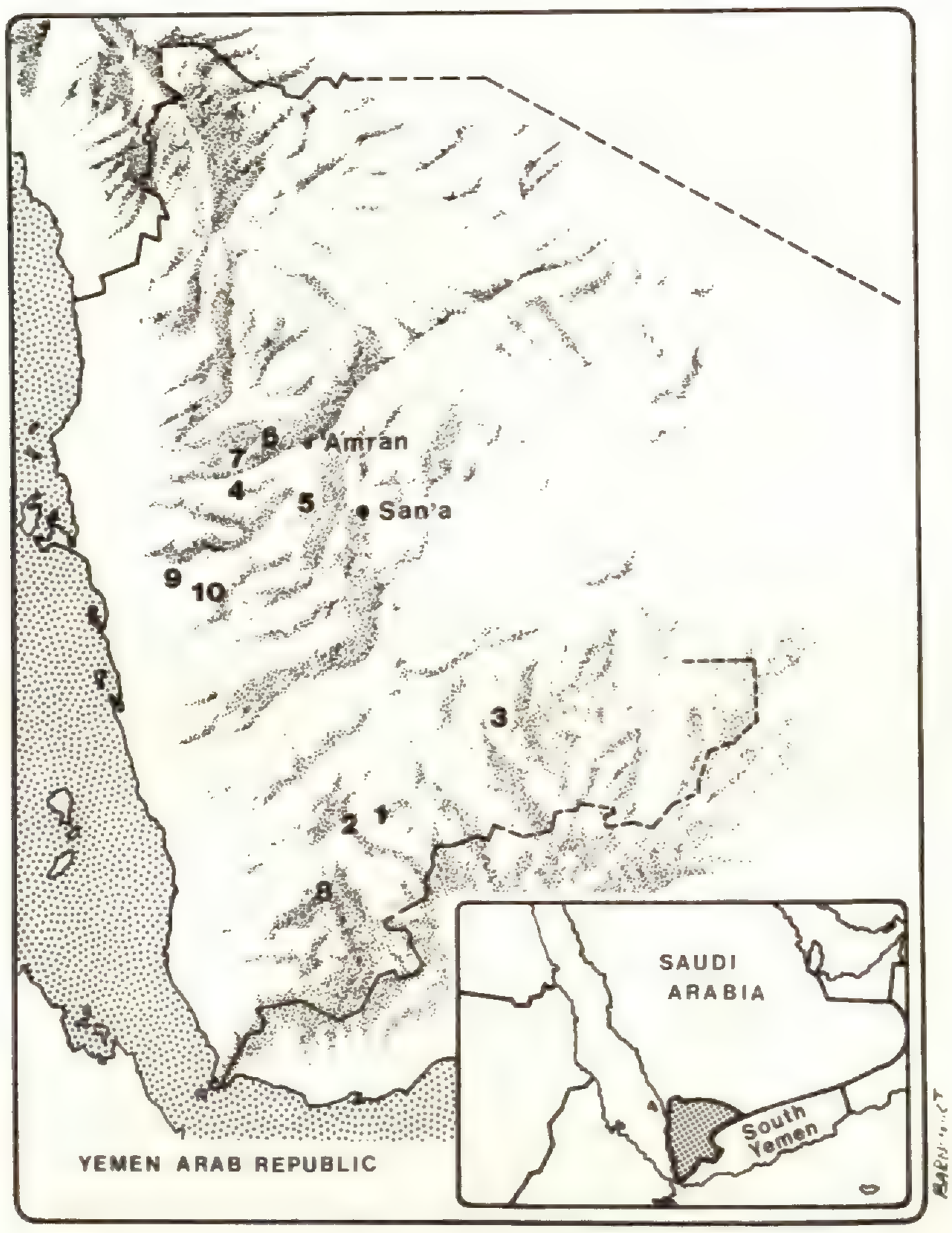

FIG. 1.—In the southern highlands the hyrax is reported #1 in the Ba'dan area (Jon Swanson, pers. comm.), #2 near Jibla (Nadeem Ashuraey, pers. comm.), and #3 Rada' ('Aish al-Nussiry, pers. comm.). In the central highlands it is reported in #4 al-Mahwit (Richard Tutwiler, pers. comm.), #5 al-Ahjur (Varisco 1982:527), and #6 al-Ashmur (Abdu al-Ashmuri, pers. comm.). In the northern highlands, it is reported around #7 Bani al-'Awwam (Jon Swanson, pers. comm.). Harrison (1968:317) reports them in the mountains near #8 Ta'izz, in the hills around the lowland town of #9 Bajil and in the #10 foothills near Sabt al-Mahrab (Stone 1985:28-29). This report concerns 'domestic' hyrax in the town of 'Amran.

DOMESTICATION AS SOCIAL PROCESS AND BIOLOGICAL RESULT

The episode of small mammal management described in this brief note takes on significance beyond its value as an ethnographic curiosity through the contribution it makes to a broader understanding of the nature of animal domestication. *Domestication* has been much discussed over the last couple of decades (see most recently Clutton-Brock 1989, in particular the contributions of Bokonyi and Ducos). This debate has gradually led to a polarization of opinion over the

proper sense of the term, a situation that threatens to slow future progress towards an historical understanding of domestication.

Two positions have been staked out. The first emphasizes the impact on the animal explaining that domestication alters the selective pressures affecting animal reproduction and development. Initially the new human-animal relationship, often labeled taming or cultural control, yields limited and perhaps unintended effects on animal morphology and behavior through genetic drift in the small tamed populations. However, at some point in the process, the potential of controlled reproduction becomes apparent to the domesticator. Then 'domestic' populations appear with new genetic and phenotypic distributions that contrast with 'wild' ancestors. Ultimately this gives rise to ever-diversifying domestic morphologies. Operationally the domestication process is expressed as technological stages. For example hunting is expected to be replaced sequentially by selective hunting, game ranching and pastoral management for meat as the flight response is reduced; Hediger (1968:15, 106) characterizes this as a conditioning of the animal from a technophobic to a technophilic psychology. This in turn is superseded by deliberate selection to amplify the capacity to generate such secondary products as fiber, milk and work. In its most extreme form the animal-impact perspective demands that human intent to modify the morphology or behavior of a wild species be present to justify the label of domestication. Said most simply *domestication is a process which results in a domestic animal.*

The contrary opinion focuses on the human side of the equation, viewing domestication as a process which incorporates animals into the social and ideological fabric of a culture. Taming creates a renewable biological asset that is simultaneously a form of capital and a consumable resource. Because domestication requires new subsistence technologies the process may demand a reallocation of the division of labor both within and between household and settlement units. Said most simply, *domestication is a process that produces domesticators.*

Both of these propositions are obviously true. However, the tendency to follow one or the other leads to sharply divergent models of the domestication process itself. Since biological changes tend to be slower paced than social ones, the animal-impact approach creates an historical record of domestication with a 'late' chronology, the human-impact perspective with an 'early' one. Endorsement of the first position draws attention to the productive potential of the animal being domesticated. The decision to domesticate is related both to the behavioral proclivity of the proposed species to be tamed and managed in meaningful numbers *and* to the domesticating society's perception of the economic advantage from doing so. Domestication is thus a rational response to such factors as population growth or resource variability (Hesse 1982).

The human-impact position emphasizes the social and ideological complexity of the technological decision. Because domestication results in a radical reordering of values it is expected to be resisted by the society's existing institutions. Thus, the possible productive advantage of animal management is seen as one achieved only at a cost. The most obvious expenses derive from the need to accumulate capital in the form of animal stock and the time lag between deciding to domesticate and the reaping of any rewards, the period of initial experimentation with animal management including its many failures and few successes. Because both of these demands deflect effort from traditional subsistence activities

the initiation of domestication lowers rather than raises total household production. A less obvious cost is the threat to the maintenance of social cohesion that results from enhancing the value of property, in particular a capital asset like livestock or seed. Those who accept the values associated with domestication, in which animals and plants are valued for their potential yield, may alienate themselves from the social network of their hunter-gatherer brethren, since the source of next year's herd or crop will be husbanded rather than shared resources. The effect will be to dilute or sour the traditional ties to people who used to be counted on in times of trouble.

Therefore in unstratified societies where the stress of maintaining a balance between population and resources can be managed by alternative, immediately effective methods—shifting to less productive gathered/hunted resources (Russell 1988, Chap. 1), relocation, settlement fragmentation, infanticide, or senilicide—it is more effective not to invent domestication. While it might make sense to expand effort on a pre-existing domestication technology, the *initiation* of domestication is an irrational response to population growth or resource variability.

However, in stratified systems characterized by differential wealth, the co-evolving politics of labor allocation and investment are seen as powerful mechanisms capable of explaining the decision to domesticate by certain sectors of society. The rich, buffered economically from demographic and environmental hazards, may invest in the domestication technology as a sort of speculation; the poor may diversify into animal keeping and marketing to provide access to the resources of the well-to-do and as an alternative income source should their subsistence pursuits fail.

Since the two models of domestication are divergent without being contradictory, it is possible to employ both in the case of the hyrax and its husbandry in Yemen described here. On the one hand, socioeconomic factors account for the decision to experiment with hyrax husbandry and provide an historical context for understanding the innovation. On the other hand, the biology and behavior of the animal as they are linked to available management techniques seem to be critical in explaining the failure to produce a new and successful domestic resource.

HYRAX BEHAVIOR, ZOOGEOGRAPHY, AND TAXONOMY

Members of the Hyracoidea of Africa and Asia are known by a variety of vernacular terms including daman, tree hyrax, rock hyrax, dassie, and coney. Hyraces are small animals, standing about 30 cm. at the shoulder with a length of up to 75 cm (Fig. 2). In the wild, adult hyrax *(P.c. syriacus)* weights range between 2.8 and 3.6 kg for females and 2.6 and 4.6 kg for males (Harrison 1968, Mendelssohn 1965, Olds and Shoshani 1982). Some data suggest that captive hyraces weigh more than feral animals. Flower (1932:431) reports that wild animals range from 2 to 2.5 kg with captives weighing 3.26 to 4.25 kg.[1] One hyrax (subspecies not known) in the Jimmy Morgan Zoo, Birmingham, Alabama, weighs just over nine kg (Robert Truett, pers. com.), perhaps indicating that captives may become grossly obese.

According to Mendelssohn (1965) hyraces can live more than 12 years. Sexual maturity is reached at about 16 months and full body size is achieved at about three years. The gestation period of seven to eight months is abnormally long for an animal of its size (Mendelssohn 1965). Although some subspecies may bear up to six young (Dorst and Dandelot 1970), hyraces average three offspring which are well developed at birth (Olds and Shoshani 1982). While Hardy's report (1947) of a young hyrax being successfully adopted by a Kurdish dog may overstate the minimal requirements of hyrax nursery, Dorst and Dandelot (1970) note that young may be collectively raised.

FIG. 2.—The hyrax of Yemen, *Procavia capensis jayakari.*

Hyraces are thigmotactic (crowding together) animals with group sizes as large as 80 individuals (Olds and Shoshani 1982). Colonies are divided into polygynous groups. They are diurnal foragers with omnivorous palates. Their habit of utilizing communal latrines produces concentrations of feces and dried urine, which some African groups collect and use (see below). They are not burrowers but inhabit the nooks and crevices of rocky terrain for protection both from predators and climatic extremes.

The hyrax is found in the Levant and the Arabian Peninsula. In addition to contemporary sightings discussed below, Doughty (1936) observed hyraces in central Arabia in the 1880s, Bury (1915) reports seeing them at 'midaltitudes' in Yemen at about the turn of the century, and Musil (1928) saw them in the northern part of the Arabian peninsula in the 1920s (Fig. 1).[2] These sightings are in the region dominated by the Serat Mountains, a rugged range with average elevations of 2,000 to 3,000 meters that extends north along the Red Sea coast through the Yemen Arab Republic into Saudi Arabia. The climate in these mountains is mild and the southern portion is relatively well watered.[3]

Usually hyrax are placed into three genera (Bothma 1971, Hoeck 1978, Olds and Shoshani 1982) although Roche (1972) suggests only two. All of those in Arabia and the Levant are referred to the species *Procavia capensis.* Harrison (1968) divides the hyrax in this region into two subspecies differentiated primarily by size. The larger subspecies, *P. c. syriaca,* is found in northern Arabia and the smaller, *P. c. jayakari,* in southern portions of the peninsula. The boundary between the subspecies is located in the vicinity of al-Ta'if, near the northern limit of the Serat mountain chain.

HYRACES IN YEMEN

There have been many contemporary sightings in the Yemen Arab Republic (Fig. 1). The present report concerns "domestic" hyraces captured in the hills around the town of 'Amran.

Yemeni hunt hyrax for its meat as well as for sport (Swanson, pers. com.; Tutwiler, pers. com.).[4] Harrison reports that hyrax is prescribed to increase potency (Stone 1985:28-29) but does not suggest how it is prepared. In 'Amran and elsewhere, the broth is considered particularly good in reducing swellings.

Hoogstraal (1952:220), describing the hyrax in Yemen, notes that "in East Africa it is valued for its thick, soft fur which is often made into rugs." While the Arabic term, ***wabr***, connotes both hyrax and fur, neither this latter meaning nor the fur seem to be in use in Yemen today. Moreover, unlike cultural practices in Africa, the urine and feces are not converted for medicinal purposes or perfume (Hardy 1947, Kingdon 1974).

HYRAX HUSBANDRY IN 'AMRAN

'Amran is a market town of about 9,000 residents in Yemen's central highlands about 50 km northwest of the capital, San'a. The region is relatively dry, relying on seasonal rain to produce the major crops of cereals. Traditional agricultural households kept few domestic animals, generally donkeys and bulls used for traction and the occasional milch goat or cow. With the exceptions of livestock brokers, butchers, shepherds, and the now rare caravan operator, individual management of large numbers of animals was unknown. Household animals are fed the remains of harvested crops or freshly cut and purchased alfalfa.

Traditional Yemeni architecture inhibited the housing of livestock. The typical house was of four storeys, abutting others on two sides, and facing directly onto the street. All animals were kept in dark rooms on the ground floor. The chicken was the most commonly kept small animal; a few houses maintained rabbits. Although new houses tend toward one storey, villa styles often including a courtyard, generally these walled areas are not used for animals.

Hyrax keeping was noted during ethnographic field research in 'Amran in 1978, when animals were observed in three households. While no confirmation survey was undertaken, women keeping hyraces reported this practice to be common. This was taken to mean the practice was not new, although it was new to these owners. However, since neither a survey of Yemeni agriculture (Tutwiler and Carapico 1981) nor the 1975 geographic survey and census (Steffen *et al.* 1978) make reference to the hyrax as a domesticate, it seems clear that while 'Amranis are aware of the practice and know where to obtain animals, this is an isolated case. In 1987 when a search was made for hyrax keepers, only one household was located. None of the households that in 1978 had hyraces still had animals. Households with hyraces were clearly at the low end of the socio-economic spectrum.

Two methods of hyrax management were observed. In 1978, animals were kept in a narrow crawl-space storage area between the ground and first floors of traditional houses. With walls of mud and straw bricks and floors of mud and

straw applied over supporting branches, these areas were constantly dark and cool. It was estimated that there were 12-15 hyraces in one room. In one case each in 1978 and in 1987, the hyraces were kept in enclosed wooden boxes in the courtyards of villa style houses. The boxes were kept in the shade and were provided with only a few air holes. Raisers know hyrax are not prone to digging under walls like rabbits and so are easier to contain, but believe the animals prefer the dark. Hyraces are fed left over breads and fresh cut alfalfa, and are supplied with water.

Women are the owners and managers of all small animals. In general, owners did not seem to have extensive or intimate knowledge of hyrax reproductive patterns or gestation period. Although the owner observed in 1987 could not sex her animals, she was expecting her pair to reproduce. Some former owners said they did not know what went on in the dark.

These "management" techniques were not successful. Although an estimated 40 animals were observed in 1978, the owners reported that they all died, probably by the end of 1979. One owner reported buying new stock and attempting to reported buying new stock and attempting to raise them in cages on the roof. These also died. Another owner reported that it was the young that tended to die, and implied that, like rabbits, there were some hyraces that were 'domestic' and did well in captivity and others which were 'wild' and did not. While this might suggest two groups of animals, it is more likely the speaker was referring to the animals' temperament.

There is little information on how the hyraces were obtained, but there is agreement that they were very hard to catch. Some report the wild adults are killed and the young are captured. Others say they are caught in nets thrown over their lairs. One woman reported that her father, a skilled hunter and a man of very low ascribed status in the Yemeni social hierarchy, caught them. Efforts are made to obtain both sexes.

MOTIVATION FOR ATTEMPTED DOMESTICATION

The mid to late 1970s was a period of rapid economic change in Yemen characterized by a growth of commerce and a decline in subsistence farming. The shift to a cash economy was accompanied by high inflation brought on by the influx of funds earned in expatriate labor in Saudi Arabia and the Gulf States. As none of the hyrax owners' households had a stable cash source, it appears they entered the business with the intent of earning extra income. Given raisers lack of knowledge about hyraces, it may be inferred they expected hyrax husbandry to be uncomplicated, perhaps comparable to raising rabbits.[5] Additional impetus may have been provided by the availability of animals. In apparent contrast to the situation in 1987, informants reported that in the late 1970s hyraces were plentiful and easy to catch.

Hyraces are not sold in the market. Customers seek out the breeder and buy at the "farm-gate." It is fairly easy to learn who has hyraces for sale. The prices in the late 1970s were estimated to have been about 20 Yemeni riyals (then about $4.50) for an adult. In 1987, immature animals were sold for 30 YR and adults for 50 YR (then between $4.20 and $6.20). Adults were defined as being over seven

months of age. Although there is no information on the 1978 sales volume, in 1987 there were few sales.

Yemeni meats include mutton, beef, chicken, and rarely camel and goat. In 1978 mutton sold for 70 YR/kg and beef for 20-30 YR/kg. Most chickens were imported frozen and sold for prices of about 10 YR/kg. Smaller, 'indigenous' chickens sold for about 40 YR and were eaten rarely. These meat prices still obtained in 1986 except that frozen imported chicken had been replaced by birds raised locally from imported eggs. Local chickens weighed between 0.5 kg and 0.75 kg and sold for 25 YR. Cooked hyrax observed by the senior author seemed to have as much meat as a 1 kg chicken and less meat than 20 YR worth of beef.

Hyraces are skinned, dressed, and cut in pieces (including the head) for cooking. Like all meat, hyrax is boiled in water with spices. Both the broth and the meat is consumed. Yemeni report the meat tastes like lamb, the highest quality meat in Yemen. In fact, to the author, both in texture and taste, hyrax seems to be indistinguishable from chicken.

Comparatively, then, the hyrax could have been a competitive meat source. Further, the medicinal value of the broth would have insured a small but stable market. Finally, since Yemeni prefer and will pay higher prices for any locally produced food, the hyrax would have been a suitable food and income source.

DISCUSSION AND CONCLUSION

These data correspond to the models of animal domestication presented above. Hyrax production was done on a household basis as part of women's economic activities. Those households which attempted hyrax breeding were in a marginal economic position and were driven by the need to enter the cash economy. The objective was to supplement rather than replace existing income sources such as egg and poultry production. Without this stimulus the attempt probably would not have been made. This, coupled with the relative ease with which the species could be otained, the prospect that a relatively inexpensive, local meat would enjoy strong sales, and the medicinal qualities attributed to the meat, seem adequate explanation for trying to domesticate the hyrax.

Prospects for the continued raising of hyraces are dim. Either the animal or Yemeni livestock management techniques appear inadequate to the task. While raisers are unsure about the period of gestation and age of reproducton, it seems unlikely that obtaining this information would make hyrax husbandry viable, since the late reproductive age and lengthy gestation of the animal reduce their potential as a productive domesticate. Additionally, the high loss rate of animals substantially increases the cost per individual. Also of importance is that prior to domestication, breeders seem to have known almost nothing about keeping them in captivity. While some did have experience raising rabbits, they were certainly not well versed in small livestock management techniques. Apparently it was assumed that this was either easy or that sufficient knowledge could be obtained through experience. Taking what is already known from the management of one species and combining it with trial and error experience may work with some species, but not those with the biological limitations on productivity characteristic of the hyrax.

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NOTES

[1]This involves a comparison of two subspecies, captive *P.c. syriacus* with Burton's hyrax [now *P.c. ruficeps* (Bothma 1971)].

[2]Despite widespread sitings in Arabia, the Levant, and the Sinai, hyraces are rare in Holocene archaeological samples (e.g. Noy *et al.*, 1980). However, ancient records contain the Biblical citations [Leviticus 11:5, Deuteronomy 14:7] that include it among species forbidden to the Israelites.

[3]Psalms 104:18, and Proverbs 30:24, 26 describe the hyrax's habitat as rocky (Meyer 1978: 286). A pre-Islamic poet of the Hadramaut, Muhariq b. Shihab b. Qais al-Tamimi, mocks people who live in the hyrax's habitat while praising those fortunate to live where ibex are common (Serjeant 1976:17), a habitat contrast also struck in Psalms 104.

[4]In Africa, since the Pleistocene (Brian 1981), the hyrax has been hunted. In modern East Africa the species is a minor meat resource (Dyson-Hudson and Dyson-Hudson 1970:117).

[5]No rabbit raisers were observed in 1986-87.

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Navajo Land Use: An Ethnoarchaeological Study. Klara B. Kelley. New York: Academic Press, 1986. Pp. xvi, 233. $35.00 (hardcover).

The title, *Navajo Land Use,* may be misleading, if only a bit. This general title masks an important study for specialists. Researchers interested in Navajo family land uses, the transformation of traditional peoples by market forces and public policy, or a model application of archaeological evidence will enjoy this book.

Here is a study which seeks to explain changes in Navajo family land use from 1880 to the present in a small land area of slightly more than 20 square miles. The south McKinley Mine is a strip mining area located in New Mexico, southeast of Window Rock, Arizona. *Navajo Land Use* began as a technical report on research conducted by the Office of Contract Archaeology of the University of New Mexico in 1978 and 1979.

Kelley summarizes the essential issues in Chapter 2, "Navajo Family Land Use and the Political Economy of the United States." Mercantile capitalism during the railroad era (1880–1930) altered a self-sufficient family economy as Navajos became dependent on goods from trading posts. Home industries (weaving, jewelry) and animal husbandry intensified, family sizes grew, and marginal lands became critical to expanding local production.

Federal grazing regulations defined the second era (1930–1950). Federal policies restricted herd sizes, and after World War II welfare and wage labor opportunities expanded. Navajo family sizes continued to increase.

During the third era (1950–present) industrial economic forces predominated. Cheap, mass-produced goods replaced domestic production. Jobs at strip mines and nearby towns provided wages to family members. Family land uses reflected these changes as new communities expanded along transportation routes.

Kelley argues that two themes underlie the changes in Navajo family land use from 1880 to the present. First, a case is made for the conquest and oppression of the Navajo nation by United States mercantile and industrial capitalism. A second case is made for the effect of Navajo "atomistic decision making." Chapters 4 through 18 systematically present evidence for family economy and environmental change, family demography and land tenure, spatial aspects of land use, and technology. Each of these topics is discussed in a separate chapter for each period: 1880–1930, 1930–1950, and 1950–present.

The author collected historical and ethnographic data during a year of fieldwork while living with a local family. Eighty-seven people were interviewed on archaeological sites or at their homes. Archaeological data were collected by separate archaeology crews. Documents and a field census in 1978 are used to reconstruct livelihood, environment, and demographic characteristics. Interviews and archaeological data document land tenure, spatial patterns, and technology.

One of the strengths of this study is the integration of different kinds of evidence. Documentary evidence gives a clear record of the succession of federal regulations and activities by mining interests; oral testimony and archaeological data measure changes in Navajo site locations, diet, and technology. However, the fit is not always perfect. For example, many archaeological sites during the post–1950 period were not studied because they were still occupied.

Kelley believes that the different forms of evidence are effectively combined because they intertwine the same families. On the other hand, a different point of view is possible: the different forms of evidence may be treated as separate avenues, if not independent variables, for exploring the land uses of particular Navajo families. It would be interesting if Kelley would follow this study with another which explores the land use strategies of individual families from 1880 to the present. It also would be interesting to see a treatment of the evidence which evaluates and tests the relationships among variables.

The use of archaeological evidence in this study is particularly noteworthy. The author combines a very complete material cultural record of a 20-square-mile area with oral testimony, family histories, and documents. This type of archaeological evidence, when collected, is usually filed as a technical contract report. These studies are rarely unearthed. *Navajo Land Use* has exhumed an important record.

It is important to emphasize that only one chapter, of three pages, is devoted to an ethnoarchaeological perspective. The references tell the story. Here is a work that uniquely focuses on the Navajo people. Specifically, it draws on evidence for a few dozen families which underwent change from 1880 to the present. For the reader who enjoys focusing on details and can generalize to other cases, this is an exemplary ethnoarchaeological study.

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THE F.W. PUTNAM-EDWARD PALMER RELATIONS IN THE DEVELOPMENT OF EARLY AMERICAN ETHNOBOTANY

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ABSTRACT.—F.W. Putnam (1839–1915), Curator of the Peabody Museum of American Archaeology and Ethnology at Harvard University, gave encouragement, aid, and financial support to Dr. Edward Palmer (1831–1911), a professional collector of plants and anthropological artifacts. Palmer collected widely in the southwestern U.S. and in northern Mexico for the U.S. Department of Agriculture, Geological Survey of California, Peabody Museum and Gray Herbarium of Harvard, and the Smithsonian Institution (U.S. Bureau of Ethnology and National Herbarium), and assembled copious notes on the uses of plants by the Indians. His work became the foundation for American ethnobotany. Correspondence Palmer sent to Putnam concerning financial aid, plans for the future, and progress in conducting the field work are presented.

RESUMEN.—F.W. Putnam (1839–1915), conservador del Museo Peabody de Arqueologia y Etnologia Americana de la Universidad de Harvard, dio estimulo, ayuda y apoyo financiero al Dr. Edward Palmer (1831–1911), un colector profesional de plantas y artefactos antropológicos. Palmer realizó extensas colectas en el suroeste de los Estados Unidos de Norteamérica y en el norte de Mexico para el Departamento de Agricultura de los Estados U:nidos, la Exploración Geológica de California, el Museo Peabody y el Herbario Gray de Harvard, y la Institución Smithsoniana (Herbario Nacional y Oficina de Etnologia de los Estados Unidos), y recabó voluminosas notas sobre los usos de las plantas por parte de los indigenas. Su trabajo ilegó a ser la base de la etnobotánica norteamericana. Se presenta aqui correspondencia que Palmer le envió a Putnam referente a ayuda financiera, planes para el futuro, y avances en el trabajo de campo.

RESUME.—F.W. Putnam (1839–1915), conservateur du Musée Peabody de Archéologie et Ethnologie de la Université de Harvard a donne encouragement et assistance financière au Dr. Edward Palmer (1831–1911), collecteur de profession de plantes et d'objets archéologiques. Palmer a collectionné largement dans le sudouest des États Unis e dans le nord du Mexique pour le Départment Américain d'Agriculture, le ''Survey'' Geologique de la Californie, le Musée Peabody et l'Herbier de Harvard et l'Institute Smithsonian (le Bureau Américain de Ethnologie et l'Herbier National), et a assemblé de notes copieuses sur les usages de plantes pour les Indiens. Son travaille a devenu la fondation de l'ethnobotanique américaine. Correspondance enviée pour Palmer a Putnam concernant l'assistance financière, des projets à l'avenir, et son progrés dans les travaux en champ se present ici.

INTRODUCTION

Frederic W. Putnam (1839–1915) was trained in zoology by Louis Agassiz at the Musem of Comparative Zoology, Harvard University. He began his scientific career as an ichthyologist and museum administrator, but in 1875 shifted his specialty to American anthropology when he was appointed as Curator for the embryonic Peabody Museum of American Archaeology and Ethnology on the Harvard campus (Dexter 1966, 1980). He retained a life-long interest in natural history and approached his own anthropological research from a biological point of view. In the course of his field work on American archaeology, he included ethnobiology (Dexter 1985). Also he encouraged others, such as Dr. Edward Palmer, and gave them financial support whenever he was able to do so.

Edward Palmer (1831–1911) was born in Norfolk County, England, the son of a florist and horticulturist (his life and career have been outlined by Safford (1911), but the year of birth is given incorrectly). At age 18 he emigrated to the United States, settling in Cleveland, Ohio, where he came under the influence of Dr. Jared Potter Kirtland, prominent physician and the first important naturalist in northern Ohio, who encouraged Palmer to study natural history. Dr. Kirtland instructed the young Palmer in methods of collecting and preserving plants and animals. On a U.S. government collection expedition to Paraguay (ship *Water Witch)* organized in 1853, he assisted the ship's surgeon as an apprentice and hospital steward as well as serving as a naturalist for some two years (the La Plata River Expedition under command of Lt. Thomas J. Page, U.S. Navy). Later, he obtained some medical instruction for a few months at the Cleveland Homeopathic College, but it was primarily his practical experience on ship board that qualified him for the title of ''doctor'' and led to an appointment (1862) as Acting Assistant Surgeon in the U.S. Army during the Civil War. After the war, Dr. Palmer practiced medicine in the western territories and became a professional field collector. He collected especially plants, and some archaeological and ethnological specimens, but his major contribution to science was his pioneering work in ethnobotany of the Indians in the southwestern U.S. and northern Mexico.

Harshberger (1896) early pointed out the usefulness of studying ethnobotany while Robbins, Harrington, and Freire-Marreco (1916) outlined the scope of ethnobotany. Gilmore (1932) reviewed the importance, usefulness, and methods of ethnobotany, and Carter (1950:74) advocated a wider use of ethnobotany in his statement that ''It is probable that ecologists and geographers, too, could profitably follow the ethnobotanist and study all the plants affected by man's presence, and that all would benefit by considering a longer span of time than has been customary.''

Hough (1911:173), soon after Palmer's death, declared him to be ''an assiduous collector in ethnology and natural history.'' McVaugh (1956) published a volume on the life and work of Palmer, especially his career in collecting plants in the western territories. Bye (1972:88–89) in his study of ethnobotany of the Southern Paiute Indians included a sketch of Palmer's life and career as a professional collector, and explained the relation of Palmer to F.W. Putnam thus, ''Palmer enticed the academic appetite of Frederic Ward Putnam of the Peabody Museum,

Harvard University, with a few duplicates of the 1875 excavations. As a result, the Peabody Museum hired Palmer during 1876–1877 to excavate other reported mounds in southwestern Utah. Palmer arrived in December 1876 and worked until the summer of 1877. He also collected botanical, zoological, and mineral ore samples from this region. Ethnobotanically, this trip was an important one. Case specimens of roots, seeds, and plants were sent to the Peabody Museum with notes of names and uses. ... These specimens and notes formed part of Palmer's (1878) second and most important botanical paper, 'Plants used by the Indians of the United States.' '' Bye (1972:101) concluded that ''Palmer laid the foundation for modern ethnobotany in western United States and Mexico.'' Later Bye (1979:135) wrote ''Palmer's contribution—often unacknowledged—is the cornerstone of modern ethnobotanical research in North America.''

PALMER'S FIELD WORK

Dr. Palmer collected plants under the direction of Dr. James G. Cooper for the Geological Survey of California in the late 1850s. In 1869 he was sent by the U.S. Commissioner of Agriculture to New Mexico and Arizona to report on agricultural resources with special reference to food plants used by the Indians. He collected both plants and ethnological objects. Following that he went to Sonora, lower California, and to Utah to collect plants. This led to his first important work (Palmer 1871, published anonymously, but generally known as his monograph). It was recognized as the first significant study of North American ethnobotany. Castetter (1944:158) regarded it as ''the first attempt to present a systematic statement of the subject.'' Palmer (1873; 1874) subsequently published brief notes on the use of *Rhamnus croceus* as Indian food and Indian rope and cloth. Later, he again published (1889; 1891) brief notes on *Opuntia* fruit as food and Indian methods of preparing wool and cotton. Dr. John Torrey wrote to him that ''You have in the last few years done great service to North American botany, and I trust that we shall receive yet greater benefit from your explorations'' (Safford 1911:346).

In 1875 Palmer collected plants and information on their uses by natives at Guadalupe, Mexico, in southern California, and southwestern Utah. He published some brief notes (Palmer 1878a,b,c) and then a major work (Palmer 1878d) on plant utilization based on field work done since his paper of 1871. His manuscript was sent to Putnam, one of the founders and first editors of the *American Naturalist* published by Putnam's Salem Press (Dexter 1956). At about the same time, Palmer sent to Putnam a leaflet issued by the Smithsonian Institution in 1877 listing plants used by American Indians for food, medicine, etc. and distributed to various museums and herbaria (Item no. 428, Letter Book no. 4, Peabody Museum of Archaeology and Ethnology archives). Of the 61 plants listed with notes on uses, 24 had been collected by Dr. Palmer.

From Utah he went to San Bernardino, California, to replenish supplies, then on to Arizona, back to Utah in December 1876 to collect for the Peabody Museum. He wrote to Putnam 11 December 1876 from Davenport, Iowa, while preparing for field work at St. George, Utah, ''I shall go at once to St. George and work on the mounds there, it being warmer. The entire results with notes etc. according

to our agreement will be sent promptly to you ... Many thanks for your efforts in getting the money and hope your expectations will be realized as I assure everything that can, will be done by me to render satisfaction to yourself and Museum.'' (Letter in archives of Peabody Museum of Archaeology and Ethnology.) In 1879–1880 he collected in Texas and in Mexico. On 12 January 1880 he wrote to Putnam from San Antonio, ''Am sorry the Peabody Museum cannot furnish means to assist me in Mexico as it is an important field; hope you will be able to raise some means outside and send it to me in Mexico [in] New York drafts. Today ship the last of my collecting ... three packages of plants for Prof. Gray'' [Harvard Herbarium]. (Correspondence of Palmer to Putnam here and hereafter is in the archives of Harvard University.) Eight days later he wrote again, ''Hope you will be able to raise funds so as to enable me to examine the caves for mummies and collect the rest of the Indian material in northern Mexico.'' On 12 June 1880 he wrote from Parras, Mexico, that, ''I came this way to visit the cave section 100 miles distant from which part returned a few days since. Have procured some curious things. Your Kentucky shoes [i.e. sandals—Dexter 1984] are equalled in rudeness by several pairs found made from Agave leaves and fibers, etc.'' Watson (1882, 1883) published the botanical results, but gave mostly his own descriptions of plants with only some of Palmer's field notes and a few notes on the uses of the plants.

During 1881–1884 Palmer collected plants and artifacts for the Peabody Museum of American Archaeology and Ethnology and for the U.S. Bureau of Ethnology in Tennessee, Arkansas, Indiana, North Carolina, Georgia, and Alabama. In 1881 Putnam tried to get a position for Palmer with a Lake Superior Survey, but he decided to remain working for Spencer F. Baird, Secretary of the Smithsonian Institution and Director of the U.S. National Museum. Palmer wrote Putnam from Helena, Arkansas, 10 January 1882, ''As soon as I hear from him [Baird] will answer your letter regarding the position you were so kind as to recommend me to. I think it would be a delightful trip and Prof. Pumpelly has great experience and there would be no military about it.'' However, he chose to collect specimens for the Smithsonian Institution, with its bureau of Ethnology and U.S. National Herbarium.

On a visit to Washington, D.C., Palmer wrote to Putnam 15 March 1882, ''Has Mr. [Lucien] Carr published his paper on corn as used by Indians? I think he said it was to be published in the Kentucky Survey Report.'' Carr was Putnam's Assistant Curator at the Peabody Museum who published a major work on the foods and methods of their preparation by American Indians (Carr 1895).

In 1885 Palmer studied the ethnobotany of Indians in the southwestern U.S. Again, Watson (1886, 1887) published his descriptions of the plants collected, but included only a few of Palmer's field notes and indications of plant uses. On another visit to Washington D.C., Palmer wrote to Putnam 9 February 1888, ''Just returned from the region of Guayana Sonora, Mexico, to which place went last June. Made principally botanical specimens, about 600 species!'' On 17 May 1888 he wrote again, ''I have been sick most of the winter ... as medical advice recommends me to go to a mountain region so in a day or two will start for San Bernardino, Southern California, to meet a party desiring to go with me to the mountain region of the west side of Guatemala. ... It's a new country to me, but

guess something is to be found worth bringing away.'' While in California he collected plants for the Department of Agriculture before his departure for Mexico, and reports of plants from both areas, with his field notes and notes on utilization, were subsequently published by Vasey and Rose (1890a, b). Two years later Palmer collected plants in lower California, Arizona, and western Mexico. Again, the plants with field notes and uses were published by Vasey and Rose (1890c) and by Rose (1891, 1892, 1895). Upon his return to Washington D.C., Palmer wrote again to Putnam on 15 June 1891, ''After an absence of three years mostly in Mexico, returned to this city. Collections made give entire satisfaction, Botanical collections quite full containing many new species and some [new] genera. ... There is some talk of sending me to Mexico again botanizing. ... Mexico is very strict regarding shipping antiquities out of the country. So far have succeeded in passing my collections among packages of botanical specimens.'' He made his last trip to Mexico in 1910 when he collected along the Gulf Coast near Tampico, Tamaulipas.

During 1899–1900, a course on uses of plants by American Indians was given at the Peabody Museum for students at Radcliffe College by Dr. Frank Russell, a former student of Putnam's, and an instructor in the Department of American Archaeology and Ethnology, Harvard University. The substance of the course was summarized by Chamberlain (1901), including much of Palmer's publications and papers based on his work.

DISCUSSION

In addition to his field work on the uses of plants by North American Indians, Dr. Palmer collected over 100,000 specimens of plants and discovered 1,162 new species, some 200 of them named after him (Safford, 1911). However, he is best known as a pioneer in developing American ethnobotany. Castetter (1935) and Maurice (1950) made frequent reference to his work, and Yanovsky (1936), in his summary of literature on food plants of American aborigines, reported that from a total of 1,112 species listed, Palmer published notes on 164 species. Kidwell (1973:46) emphasized that ''It is probably in the field of botany that there is the strongest basis for attributing to Indians the use of scientific method in connection with nature. The observation of plants and knowledge of their uses indicates a pragmatic concern with natural phenomena.'' In developing our understanding of such matters, Ford (1978:38) has stated that, ''The best studies of Indian uses of plants came from botanists. If any scientist epitomized the new trend, it was Edward Palmer, who not only described the vegetation of the West, but also made inquiries about plants useful to the Indian people he deliberately visited.'' F.W. Putnam of Harvard University was instrumental in aiding Dr. Palmer's pioneering work in ethnobotany.

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I am indebted to the heirs of F.W. Putnam for use of his personal papers, and to the archives of the Peabody Museum of Archaeology and Ethnology and the archives of Harvard University, where most of the Putnam papers are deposited, and to their archivists

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BOOK REVIEW

Meeting Our Ancestors: What Can Their Bones Tell Us/Rencontre avec nos ancetres: ce que nous revelent keurs ossements. Robert Larocque (Rosemarie Bernard & Moira T. McCaffrey, transls.). Montreal: Recherches Amerindiennes au Quebec, 1985. Pp. 64/64. CAN $6.00 (softcover).

With a scant 36 pages of text, 15½ pages of superb black-and-white photographs, and a 4-page bibliography which concentrates on French-language sources, this engaging little book is an excellent introduction to skeletal analysis for the lay person who never knew or cared anything about the excavation and analysis of human remains. Published by Recherches Amerindiennes au Quebec, it was originally written for French-speakers who had not previously had ready access to materials on the subject. The French original and its English translation are bound together in a single volume. The English text suffers from a few awkward translations and sweeping generalizatons, but these are relatively insignificant given the fact that the book is primarily aimed at the nonspecialist.

Chapter headings include: The work of anthropologists; How bones are treated (On the archaeological site and In the laboratory); What can be learned from the analysis of human skeletal remains (Physical traits and Traces of disease); Mortuary practices and their significance; Research in Quebec; Ethical and legal questions; History and archaeology: what is the difference?; and a Conclusion. Each chapter consists of a 1-10-page, non-technical introduction to the topic. Discussion focusses on what can be done, to the exclusion of how. The two-page discussion of nutritional diseases (pp. 34–35), for instance, suggests that agriculturalists and hunter-gatherers have different diets, sometimes reflected in a higher level of dental caries among agriculturalists; that anemia, scurvy, and rickets leave scars on bones; and that "the quantity of each type of food we consume determines the proportion of some of the substances that make up bone." What these substances, the types of food that affect them, or the "series of complex biochemical analyses" necessary to detect them, may be, is beyond the scope of this book. Readers seeking discussions of carbon, nitrogen, and strontium isotope ratios will not find them here. They may wish instead to consult articles like "Chemistry and Paleodietary Research: No More Easy Answers," by Andrew Sillen *et al.* in *American Antiquity* 54(3):504–512.

Canadian readers should find this a useful book to keep in the office and hand to bulldozer operators or backyard gardeners who report digging up bones. They may also wish to show the excellent photographs to students in introductory classes. American readers should be warned, however, that the discussion of ethical and legal questions, while sensitive, reflects only the situation in Quebec. The legal situation is different in the United States, and some Native American groups in this country object to publication of photographs like Figures 1 and 2. It is unfortunate that no publication of this level and quality is available to deal with the situation in the United States. If it were, human remains discovered by chance in this country might receive better treatment, and some of the misunderstandings between paleoanthropologists and the lay public might be reduced.

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CROSS-CULTURAL AND HISTORICAL COMPARISONS IN THE PALATABILITY OF SEVERAL EGYPTIAN BIRD SPECIES

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ABSTRACT.—Eighteen samples of meat, representing 14 species of birds and one species of domestic mammal, were anonymously presented to a taste-testing panel. The panel, composed of five Egyptians and eight Americans, rated the meats using a scoring system from 5 (excellent) to 1 (very poor, almost inedible). Intra- and inter-cultural differences in the palatability of the various meats are discussed, as well as historical changes in the use of certain birds as food.

RESUMEN.—Con el objeto de poner a prueba de sabor, se presentó a un grupo selecto, de forma anónima, diez y ocho muestras de carne. Entre dichas muestras se encontraban representados catorce generos de aves y un mamífero doméstico. Este grupo, consistió de cinco egipcios y ocho estadounidenses, que clasificaron las carnes usando un sistema de calificación de 5 (excelente) a 1 (de mal sabor, casi incomible). Se discutieron las diferencias intra- e inter-culturales de saborear distintas carnes, así como también se discutieron cambios historicos del consumo de ciertas aves como alimento.

RESUME.—On a presenté anonymement 18 échantillons de la viande de 14 espéces des oiseaux et d'une espéce de mammifére domestique à quelques personnes pour demander ses opinions gastronomiques. Les 5 égyptiens et 8 américains ont évalué les viandes selon un systéme de classification de 5 (excellente) jusqu'á l (tres mauvaise, presque incomestible). On discute les differences entre les cultures et dans le même culture selon l'acceptabilité des divers viandes. On discute aussi les changements historiques dans l'usage de certains oiseaux comme l'aliment.

"What is food to one man may be fierce poison to others."
—Lucretius, *De Rerum Natura*

"O ye people! Eat of what is on earth, Lawful and good;
and do not follow the footsteps of the Evil One."
—*The Koran,* Surah 2, verse 168 (Ali 1983:66)

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INTRODUCTION

Over the years, an intractible debate has raged over the issue of whether dietary prohibitions are related mainly to cultural or ecological exigencies. The ''materialist'' or ''ecological'' school insists that, intentionally or not, food taboos serve to maintain checks and balances between people and their environments. McDonald (1977:743), for example, argues that food taboos function to conserve scarce game resources. Ross (1978:2, 15), also in ecological terms, believes that cultural explanations alone are too general; instead taboos relate to the ''total adaptational pattern'' of a given culture to its environment: ''It is no longer plausible to maintain that differences in dietary behavior are simply the consequence of dissimiliarities in world view,'' he concludes. On the other hand proponents of culture as a ''superorganic'' phenomenon and cautious cultural ecologists respectively discount and temper arguments for environments' bearing on food prohibitions. Carnerio (1978:20) admonishes that not every taboo ''starts out as a cognitive counterpart of adaptive behavior. Indeed we must guard against the tendency to push ecological explanations too far . . . there is always a residue of culture that may never be explainable ecologically.'' A step yet further away from the materialists' explanations, ''mentalists'' point out that there is often no logical, economic or ecological basis whatsoever for food selection. Gordon (1983:17, 24), for example, remarks that ''diet has always been influenced by non-nutritional factors [and embraces] a system of meanings and values that transcend the material content of the food and the ways in which it affects our bodies.'' Simoons (1961:106), author of the classic treatise on food avoidance in the Old World, reviews but finally shys altogether away from ecological explanations of taboos: ''the foods used by a group are chosen in accordance with cultural attitudes and patterns towards food—the group foodways . . . Western man, despite his frequent temptation to claim that *his* foodways are based on rational considerations, is no more rational in this than other men, for it makes no better sense to reject nutritious dogflesh, horseflesh, grasshoppers and termites as food than to reject beef or chicken flesh.'' Rea (1981:81) concluded that the resource utilization and food taboos of several Sonoran Desert cultures were not constrained by ecological determinism, ''but that there are ecologically imposed limits to dietary selectivity.''

In observing Egyptian foodways, we were intrigued with this core issue of permissible and prohibited foods, but dismayed by the conventional choice to be made between cultural and ecological explanations of such foodways. Our interests focused not so much on black-and-white choices between tabooed and allowable food as on the grey area between permissibility and revulsion, DeBoer's (1987:45) zone ''somewhere between the gastric and the cerebral'' that seems to be visited so regularly in the Egyptian diet. Moreover, as American expatriates living in Egypt, we were afforded the opportunity of being able to study food preferences on a cross-cultural basis. And finally, we recognized the opportunity to remove cultural preconceptions altogether from given food items, and compare the results cross-culturally. This paper describes the experiment and results that followed.

Several questions arose. The first was that, if no taboos were violated, and all preconceived notions of palatability were discarded, how would people react to the taste of foods? Secondly, we wanted to determine how particular foods, devoid of their cultural connotations, might appeal to modern members of different cultures. Third, we wanted to know whether there might be general cross-cultural differences in modern perceptions of palatability. Finally, we felt that historical comparisons would help contrast our study against the particular cultures and species examined, and allow us to examine the evolution of the cultural palate through time.

METHODS AND MATERIALS

We compared the taste preferences of members of parallel classes of two societies toward a single food group. We therefore chose to compare perceptions of wild bird meats between middle-class, urbanized Egyptians and Americans. The participants were told only that these were "bird meats," and care was taken in both explanation and preparation to ensure that no taboos were violated. This was particularly important for the Egyptian participants, all of whom were Muslims. The relevant Islamic restrictions insist that blood be drained from the animals to be eaten while God's name is mentioned, and that no bird possessing talons be eaten (al-Qaradawi 1985:53, 56). Notably, all birds presented in the experiment were procured from Egyptian fowlers who routinely slaughter the animals in ritual fashion for their clients.

During the winter months, when considerable numbers of Palearctic bird migrants are in the Nile Delta, wild bird markets prosper in several local cities and villages (Mullie 1989). The wild birds sold in the markets of Port Said and Dumyat (Damietta) are taken in the Lake Manzala area. Some are shot, but most of these animals are netted and delivered alive to market to be sold as table fowl. Numerous species and large numbers of individuals are offered for sale. Mullie (1989) provides detailed information on the birds sold in the Nile Delta markets during the winters from 1978 to 1987.

In late December 1982 and from January to April 1983, we made several visits to the Port Said market to obtain wild birds for museum specimens. The birds were prepared as skeletons and study skins, and all are deposited in The University of Michigan Museum of Zoology, Ann Arbor. Within 12 hours of death the breast muscles (Musculus pectoralis only) of several prepared birds were removed, washed, placed in a plastic bag with an identification tag, sealed tightly and frozen (for less than two months). Any portion of the muscle that had hemorrhaged by shot or had sustained other trauma was removed.

The meats were thawed, cut into small pieces and cooked without condiments, using corn oil, in an iron skillet (following essentially the procedure of Cott and Benson 1969). The skillet was cleaned and fresh oil added between the cooking for each sample. Each lot was reheated in a grate over a double-boiler before being served.

A taste-testing panel of five Egyptians and eight Americans living in Cairo was assembled. Professions and ages (in parenthesis) represented were: Egyptians—two lawyers (both 26), one student-botanist (22), one soldier (22) and one money changer (24); Americans—six university students (24, 25, 27, 27, 29 and 35), one university professor (31) and one unemployed reporter (26). All 13 participants were presented an anonymous meat sample at the same time and asked to rate the palatability of each by scoring it from 5 (excellent) to 1 (very poor, almost inedible) on individual data sheets (in both Arabic and English). Each meat was presented on a single platter and enough of each was available for several samples if any panel member so desired. Participants did not discuss their opinions until all had scored the sample in progress. On the score sheet a section was provided for comments on the texture, taste and familiarity of each sample. Egyptian participants were invited to respond in Arabic, as we were able to translate their comments.

In western Europe, particularly the British Isles, there have been clear changes in the past 600 years in the use of wild birds as food; many of the taxa involved are the same as presented to the participants of the experiment described herein. Using the historical literature we have attempted to document differences in temporal and cultural use of various wild birds as food.

RESULTS

During a single session lasting approximately 2.5 hours, 18 samples representing 15 taxa were presented to the taste-testing panel (Table 1). Sixteen samples were avian and two mammalian; the latter was viewed as a potential indicator about any general bias the panelists had towards eating fowl. As an additional control, three taxa were presented twice at spaced intervals. In all three cases the meat was obtained from two to five individuals of each taxon and mixed together, so that each reported sample contained similar proportions of several individuals. Species presented twice (sample number and mean score per sample for the Egyptians and Americans, respectively, in parentheses) include:

Gallus gallus (chicken) — sample 1 (3.0, 3.4) and sample 8 (3.8, 4.1)

Oryctolagus cuniculus (domestic rabbit) — sample 4 (1.2, 2.5) and sample 11 (2.6, 1.9)

Phalacrocorax carbo (Great Cormorant) — sample 9 (2.4, 2.7) and sample 18 (2.0, 2.9)

The ratings for each sample of the repeated taxa did not decline sharply between samples. The effect of satiation appears to have been minimal, as no appetizers were offered, and the portion of each sample provided was small. these findings are particularly relevant in our interpretation of the results of this experiment. If the mean scores of the repeated species had declined significantly from the first to second presentation, it would suggest that the participants had become bored and/or satiated, and the experiment would be of dubious value.

TABLE 1.—*Scores of bird meats by course for Egyptians and Americans in order of presentation.*

	Egyptians n=5		Americans n=8	
Sample Number and Species	Mean	Range	Mean	Range
1. *Gallus gallus* (chicken)	3.0	2–5	3.4	2–4
2. *Podiceps cristatus* (Great Crested Grebe)	2.6	1–4	3.1	1–5
3. *Recurvirostra avosetta* (Avocet)	2.2	1–4	2.8	2–4
4. *Oryctolagus cuniculus* (domestic rabbit)	1.2	1–2	2.5	1–4
5. *Ardea cinerea* (Gray Heron)	2.4	1–3	3.3	1–5
6. *Anas acuta* (Northern Pintail)	1.8	1–4	3.5	3–4
7. *Larus fuscus* (Lesser Black-backed Gull)	2.8	1–5	3.4	2–5
8. *Gallus gallus* (chicken)	3.8	2–5	4.1	2–5
9. *Phalacrocorax carbo* (Great Cormorant)	2.4	1–4	2.7	1–4
10. *Aythya nyroca* (White-eyed Duck)	2.4	1–4	3.6	2–5
11. *Oryctolagus cuniculus* (domestic rabbit)	2.6	2–5	1.9	1–3
12. *Limosa limosa* (Black-tailed Godwit)	2.6	2–4	3.3	2–4
13. *Phoenicopterus ruber* (Greater Flamingo)	2.4	1–4	3.8	3–5
14. *Anas crecca* (Green-winged Teal)	3.0	2–5	3.1	2–4
15. *Philomachus pugnax* (Ruff)	2.2	1–3	3.0	1–4
16. *Egretta garzetta* (Little Egret)	2.2	1–3	2.3	1–4
17. *Porphyrio porphyrio* (Purple Gallinule)	3.0	2–4	3.8	2–5
18. *Phalacrocorax carbo* (Great Cormorant)	2.0	1–3	2.9	1–4

Below are summary statements for each of the species presented to the panel, comments from the panel on the taste of each sample (E = Egyptian, A = American), and information about the palatability of these various taxa as perceived by different cultures.

Podiceps cristatus (Great Crested Grebe)
Egyptians — mean score 2.6, range 1–4.
Americans — mean score 3.1, range 1–5.
Panel comments: "looks strange, tastes good" (E); "like liver" (A); "good—like tender beef" (A); and "strong aftertaste, texture like liver" (A).

Opinions mentioned in the literature indicate that the flesh of this species is regarded generally as poor. Andersson (1872, cited in Cott 1946) considered it "not very palatable." Pecqueur (1963) noted that these grebes were offered for

sale in the Paris markets during February 1956, but presumably only for plumes because their flesh smells of fish. The range of scores and comments from the taste panel indicated a mixed appraisal of the palatability of this species.

Phalacrocorax carbo (Great Cormorant)

First Sample:
Egyptians — mean score, 2.4, range 1–4.
Americans — mean score 2.4, range 1–4.
Panel comments on the first sample: ''very beefy'' (A); ''fishy, sandpaper texture'' (A); and ''somewhat gamey and hint of liver'' (A).

Second Sample:
Egyptians — mean score 2.0, range 1–3.
Americans — mean score 2.9, range 1–4.
Panel comments on the second sample: ''sweet, a bit tough'' (A); ''OK, but musty tasting, a little gamey'' (A); and ''beefy in flavor, with an aftertaste'' (A). There was no comment from the Egyptian panelists for either sample.

The literature includes mixed opinions on the gastronomic quality of this species. Pecqueur (1963:120) remarked that the few birds brought to the Paris markets between 1950 and 1962 were most likely sold for plumes and that their flesh is ''tres huileuse a forte odeur de poisson. Pascomestible.''Fitzgibbon (1976) considered only young Cormorant suitable for the table, for the older birds have dark and redolent meat. However, the Duke of Bedford (Cott 1946) stated that its flavor, although musky, is not fishy, and during World War II a poulterer in Tunbridge Wells, England, offered this meat. A test panel in Zambia (Cott and Benson 1969) gave the flesh of the sub-Saharan breeding form *luqubris* [=*lucidus*] a rating of 7.0 on a scale of 9.0 (excellent) to 2.0 (inedible).

Egretta garzetta (Little Egret)
Egyptians — mean score 2.2, range 1–3.
Americans — mean score 2.3, range 1–4.
Panel comments: ''tastes like crab meat'' (E); ''very fishy, dry'' (A); ''tough'' (A); and ''good, sort of strange aftertaste'' (A).

Egrets (species unspecified) formed part of the third course of Henry IV's coronation feast in 1399 and were served at a banquet honoring John Stafford's ordination to the Episcopate in 1425 (Austin 1888). At the feast of Archbishop Nevil, in the reign of Henry IV (1399-1413), no less than a thousand egrets (species unspecified) were served (Gurney 1921). A test panel in Zambia gave the meat of this species a rating of 6.3 on a scale of 9.0 (excellent) to 2.0 (inedible) (Cott and Benson 1969).

Ardea cinerea (Gray Heron)
Egyptians — mean score 2.5, range 1–3.
Americans — mean score 3.3, range 1–5.

Panel comments: rather mixed and ranged from "very bad" (E); "absolutely wretched" (A) and "fishy" (A) to "good—beefy flavor" (A) and "very much like beef"(A).

The opinion on the worth of this species for western European tables has apparently changed in recorded history (Wheaton 1983). Early positive evaluations include: in 1399 this species was served during the coronation feast of Henry IV (Austin 1888); in the Household Book for 1507 (reign of Henry VII) kept by the Duke of Buckingham's servants, this species was mentioned several times in the household provisions (Gage 1834); in 1532 when Henry VIII entertained the King of France and the Count of Flanders at Calais, the parties consumed over 440 Gray Herons in four days (Bourne 1981); in 1555 during the ceremonies of the Serjeants of London's Inner Temple, 36 Gray Herons were served; in 1577 when Queen Elizabeth visited Kirtlige, Cambridgeshire, 28 young birds were prepared (Gurney 1921); and throughout the 16th century the Lords of the Star Chamber Court enjoyed herons at their tables (Simon 1952). By the 19th century the bird seems to have fallen from the favor in the upper class, as MacPherson (1897) noted that commoners ate adult Gray Herons in all seasons. Simon (1952) remarked that only birds with unbroken bones should be cooked, since the bones hold a fishy fluid that contaminates the meat.

Phoenicopterus ruber (Greater Flamingo)
Egyptians — mean score 2.5, range 1–4.
Americans — mean score 3.8, range 3–5.
Panel comments: "very sweet" (A); "very tender, but sour" (A); "curious aftertaste" (A); "strong aftertaste" (A); and "very good, interesting aftertaste"(A). There was no comment from the Egyptian participants.

A. Wilson (in Cott 1945) mentioned "that the flesh of the flamingo is esteemed pretty good meat and the young thought by some equal that of the partridge." Blanford (1898) concurred with this opinion and noted that they are excellent eating when in good condition. Others, however, considered them "flavourless and stringy" (Cott 1946) and "not very good" (Fitzgibbon 1976). It should be noted that the flamingo meat served to the panel was from an immature individual and presumably more tender than the flesh of a typical adult.

Anas crecca (Green-winged Teal)
Egyptians — mean score 3.0, range 2–5.
Americans — mean score 3.1, range 2–4.
Panel comments: ranged widely, from "very good, like 10 [=*Aythya nyroca*]" (A), "like duck" (E), and "good texture" (A) to "fishy, tough, overcooked" (A) and "flavor too strong" (A).

The general consensus in the literature is that this species is "greatly esteemed as an article of food" (Morris and Tegetmeier 1895). Ray (1678) noted, "This Bird for the delicate taste of its flesh, and the wholsom nourishment it affords the body doth deservedly challenge the first place among those of its kind." In recent times

(1950-62) Green-winged Teal have been offered for sale in the markets of Paris, where the meat is considered "delicate" in taste (Pecqueur 1963). It has been important historically as food in England, where gentry and royalty consumed it readily. This species was served to the diplomatic parties when Henry VIII met with the King of France and the Count of Flanders at Calais in 1532 (Bourne 1981). During the 16th century the Lords of the Star Chamber Court also indulged in this meat (Simon 1952). As of 1942 it could still be found in the markets of London (Simon 1952).

Anas acuta (Northern Pintail)
Egyptians — mean score 1.8, range 1–4.
Americans — mean score 3.5, range 3–4.
Panel comments: "like beef—sweet" (A); "texture like beef, not fishy" (A); "ok—a little tough, no tang" (A); and "tasteless" (E).

In virtually every published comment obtained on the palatability of this species the opinion was favorable, except in a few where it was noted as fishy (see Simon 1952). Yarrell (1843) noted, "This species is one of the best of the various ducks for the table; the flesh is excellent, and in great esteem." The same opinion holds generally today in Europe (Fitzgibbon 1976). However, the Egyptian participants did not uphold this view of the Northern Pintail, and they gave it the lowest mean score of all the bird meats sampled, while the Americans scored it considerably higher.

Aythya nyroca (White-eyed Pochard)
Egyptians — mean score 2.5, range 1–4.
Americans — mean score 3.6, range 2–5.
Panel comments: "pretty good" (A); "sandpaper texture, dry" (A); "very tasty and very tender" (A); and "beef taste and texture" (A). There was no comment from the Egyptian panelists.

A bird seller at Port Said called this species one of the choicest, most succulent and widely sought after ducks wintering in the Nile Delta. This opinion was independently corroborated by other informants from the Nile Delta. Fitzgibbon (1976) considered this species particularly good for brazing and *pate.* Blanford (1898), in reference to birds obtained in India, considered its meat of "inferior flavour," and Morris and Tegetmeier (1895) noted at times "it is very good, but at other times is fishy." In the markets of London, at least during the first half of the 19th century, White-eyed Ducks were sold (Yarrell 1843).

Gallus gallus (domestic chicken)

First sample:
Egyptians — mean score 3.0, range 2–5.
Americans — mean score 3.4, range 2–4.
Panel comments on the first sample: "chicken flavor" (A); "chicken?" (E); "not

bad—a bit tough—tastes like chicken'' (A); ''a little tough'' (A); and ''tough, weird taste'' (A).

Second sample:
Egyptians — mean score 3.8, range 2–5.
Americans — mean score 4.1, range 2–5.
Panel comments on the second sample: ''definitely domestic'' (A), ''very good—like very tender, very juicy chicken'' (A); ''sweet tender'' (A); ''well-cooked'' (E); and ''rubbery'' (A).

Millenia of appraisals by countless cultures have established *Gallus* as the classic table bird. In Renaissance England it was popular with the royalty, and in 1532 when Henry VIII entertained the King of France and the Count of Flanders at Calais, 5616 chickens were served to the diplomatic parties in four days (Bourne 1981). Even Red Junglefowl (the wild progenitor of our domestic chicken) are reported to e very good eating, particularly the young birds (Blanford 1898). Many members of the panel associated these two anonymously presented samples with chicken.

Porphyrio porphyrio (Purple Gallinule)
Egyptians — mean score 3.0, range 2–4.
Americans — mean score 3.8, range 2–5.
Panel comments: ''sweet'' (A), ''nice taste'' (A), and ''excellent—tastes as if sauteed in soya sauce, moist and tender'' (A), while others considered it ''salty'' (1 E and 1 A), ''fishy'' (A) and ''rubbery'' (A).

Literature on the palatability of this species is apparently scant. Meinertzhagen (1930) noted that its flesh is fishy, but not totally unpalatable. Its relatively high mean score is surprising in view of Meinertzhagen's comments. Fitzgibbon (1976), calling the meat stringy, recommended that Moorhens and Gallinules should be skinned rather than plucked.

Philomachus pugnax (Ruff)
Egyptians — mean score 2.2, range 1–3.
Americans — mean score 3.0, range 1–4.
Panel comments: ranged from ''light in flavor'' (A), to ''moldy'' (A); ''strong aftertaste'' (A); and ''heavy, tasteless'' (A). We received no written commends from Egyptian panel members.

Shorebirds in general are considered fine fare, and Ruffs ''when in good condition are excellent eating'' (Blanford 1898). In early 17th century England, Rufs were served to lords (Simon 1952). In the first half of the 19th century (Yarrell 1843), and as recently as 1922 (Simon 1952), this species was brought to English markets, where it was sold ''fatted'' or ''shot.'' In Paris markets it was offered for sale between 1950 and 1962 (Pecqueur 1963), though perhaps for plumes rather than meat.

Limosa limosa (Black-tailed Godwit)
Egyptians — mean score 2.6, range 2–4.
Americans — mean score 3.3, range 2–4.
Panel comments: "a bit sour" (E); "flavor a bit strong" (A); and "really beefy in flavor" (A).

Godwits have received wide acclaim for their gastronomic quality (Fitzgibbon 1976). Muffet (1655) noted, "but a fat Godwit is so fine and light meat, that noblemen, yea, and merchants too, by your leave, stick not to buy them at four nobles a dozen." In 1567, 22 godwits were served at a wedding in Norfolk, England, and between 1520-1550 this bird was noted commonly in the provision accounts of the le Strange household, Hunstanon, England (Gurney 1834; Gurney 1921). Blanford (1898) regarded it as especially delicious when fed on grain. A merchant in Paris offered ten adults for sale in October 1958 (Pecqueur 1963), and they could be found in the London market until at least 1922 (Simon 1952). The name godwit is from the Anglo-Saxon *god* 'good' and *wihta* an 'animal,' or perhaps literally "good eating," which presumably refers to the delicacy of its meat (Swann 1913).

Recurvirostra avosetta (Avocet)
Egyptians — mean score 2.2, range 1–4.
Americans — mean score 2.8, range 2–4.
Panel comments: varied from "good" (A) and "looks strange tastes good" (E) to "tough and dry and rather tasteless" (A) and "not much taste" (A).

Little information could be found on the palatability of this species. Anderson (1872, cited in Cott 1946) considered it "not unpalatable" and Fitzgibbon (1976) noted that it has a slight fishy flavor. In at least the first half of the 19th century it was sold in English markets (Yarrell 1843) and is still popular in the Poitou region of France (Fitzgibbon 1976).

Larus fuscus (Lesser Black-backed Gull)
Egyptians — mean score 2.8, range 1–5.
Americans — mean score 3.4, range 2–5.
Panel comments: ranged from "pretty good" (A); "OK–but tough" (A); and "a little heavy" (A) to "tough, stringy, gamey taste" (A). No comment was received from Egyptian panel members.

In modern western societies gull is generally considered poor tasting (Fitzgibbon 1976). However, in Renaissance England this does not appear to have been the case, for in the early 1400s they were part of the fare served at the wedding feast of the Earl of Devonshire (Austin 1888), and Henry VIII served gull to the King of France, the Count of Flanders and their diplomatic parties in 1532 at Calais (Bourne 1981). Gulls were purchased in the late 16th century for Lords to eat (Simon 1952). In mid-August 1634, during the visit of Charles I and Queen Henrietta Maria at Althrop, over six dozen gulls were served (Simpkinson 1860).

In the 17th century gulls were often captured alive, fattened in captivity and then consumed (Gurney 1921). Cott (1946) mentioned that a Mr. Hartley informed him that "though he expected to find the flesh [of Herring Gulls *Larus argentatus*] nauseating, this was not the case: 'The breast . . . I should describe as tasteless to faintly gamey.' "

Oryctolaqus cuniculus (domestic rabbit)

First sample:
Egyptians — mean score 1.2, range 1–2.
Americans — mean score 2.5, range 2–4.
Panel comments on the first sample: varied from "good—almost a five" (A); to "very bad indeed" (E); "rather tasteless—a bit tough" (A) and "very tough, stringy, rubbery" (A).

Second sample:
Egyptians — mean score 2.6, range 2–5.
Americans — mean score 1.9, range 1–3.
Panel comments on the second sample: "taste is good, texture gamey" (A) to "a little better than leather" (A); "rubbery" (A); and "chewy" (E).

This domestic animal is widely consumed in Egypt today and is available in most of the country's markets. In view of its popularity it was somewhat surprising that the Egyptian participants rated this meat so low. The way the meat was prepared is different from the standard Egyptian method, which may in part account for their low scores.

DISCUSSION

From the experimental results, it is clear that the sample sizes are too small to allow any useful detailed statistical analysis. Summary statistics, however, reveal several notable intra- and cross-cultural patterns (Table 1). In 17 of the 18 cases the American participants rated the samples higher on average than their Egyptian counterparts; the exception was the second sample of domestic rabbit. For several species the differences were particularly marked, for example, Northern Pintail–3.5 (A) compared to 1.8 (E). Many of the taxa the Americans rated highly are generally considered unpalatable by their recent cultural tradition. In particular these include grebe, godwit, gull, and gallinule, all of which receive a higher than average (2.5) mean score. We interpret this as showing that at least some social prejudices against the consumption of certain animals were not based on the supposed offensive nature of their meat, but rather only on cultural attitudes.

It must be pointed out that the meat of any species cannot be presumed to possess certain constant, unchanging qualities. An individual animal's diet can influence secondary compounds assimilated into their flesh and some of the supposed "offensive" birds noted above may indeed be so when they are eating certain foods. Individuals of a species may consume different foods during

different seasons, and thus, the taste of its flesh would vary. The effect of diet on meat flavor varies interspecifically, even for animals with similar diets. Further, the fattening of captive animals with raw grain, bread, and/or milk, as practiced during the Renaissance period of England, would greatly enhance their flavor.

The reason the Egyptians scored the different meats lower on the mean than the Americans is not clear. It may simply be the result of the latter group having more experience with a wider range of foods. This would be particularly true of Americans in Egypt, who through traveling have been exposed to a greater variety of foods. It should be noted that one Egyptian participant systematically rated the meats low, which reduced the mean score of this group. Also, our method of preparing the meat differed from the typical Egyptian technique for waterbirds (ducks and geese). Generally these animals are stuffed with grain and nuts, spiced with onion, pepper and cumin, and roasted (Khalil 1980; pers. obs.). Thus, it is the combination of spice and the inherent flavor of the meat that gives fowl such a high gastronomic reputation in Egyptian cuisine. This point may be exemplified by the Northern Pintail, whose meat is widely sought after by Egyptian bird market patrons, but which received an extremely low average score of 1.8 and was considered "tasteless" by the Egyptian panelists. On the other hand, Americans, particularly of the social class that took part in this experiment, often eat plainly cooked meat (e.g. steak) devoid of spice, and the taste and consistency of the meats presented to the panel may have been more familiar to the Americans than the Egyptians.

Not only can the quality of a given bird meat vary dramatically between individual animals, but a culture's perception of a given species' palatability can change significantly through time. This is exemplified by the consumption of the Gray Heron in the British Isles. In the markets of London during the 14th century a roasted heron was five times more expensive than a leg of pork (Riley 1868). During the Renaissance period this species was eaten by the gentry and royalty (see species summary above). During this time lords protected and managed heronries on their lands (Ray 1678) and some ardeids were used in quasi-medicinal ways (Broode 1547). By the early 19th century the gastronome's opinion of its flesh had changed and Selby (1833) remarked "But indeed the low estimation in which the flesh of the [Gray] Heron is now held, would seem to be in a great degree the effect of prejudice, or the fashion of taste, as, under proper treatment and good cookery, the Heron, when fat and in fine condition, is but little inferior to some of our most approved wild fowl." By the late 19th century it apparently fell completely out of approval with the upper classes and was only eaten by the common people (MacPherson 1897). Thus, as described by Felley-Harnik (1981:10), "It is owing precisely to the complex interrelationship of cultural categories that food is commonly one of the principal ways in which differences among social groups are marked."

With the advent of the Industrial Revolution in western Europe, the subsequent advances in animal husbandry (e.g. mass production of chickens), and increased efficiency in the storage of products and their distribution, the previous burden of a daily hand-to-mouth existence was partially relieved. It appears that

it was during this time that many species which had been considered desirable in the Renaissance period, or at least had been consumed by the gentry and royalty, fell out of favor. In some cases certain wild birds were taken for sport, a pastime generally available only to the upper class and often at the explicit exclusion of other classes. An important point is that it was then possible for the general public to obtain very palatable foods without abandoning nutrition and presumably those species that were not choice were no longer consumed. Certainly the ability to choose the meat of one animal over another of equal nutritional value, solely on taste, was a new luxury. Thus, as Rea (1981:80) points out, "Taboos are a luxury."

Similar phenomena of changing preferences and perceptions of palatability may be noted in Egypt. The recent introduction of modern animal farming practices into Egypt (e.g. modern poultry factories), as well as western cultural ideas, seems to have resulted in a change in the more traditional meats consumed, particularly in the larger cities. This was presumably accomplished by more efficient, or at least greater mass production of several domestic animals, and a network for their distribution. Thus, there has been a shift to domestic animals. The people consuming wild birds purchased in the Nile Delta markets are generally members of the higher Egyptian social classes. The price per unit weight of meat (£ Egyptian/kg meat) of many wild birds for sale in these markets exceeds that for some domesticated animals. For example, as of the early 1980s the approximate cost of Little Bittern *(Ixobrychus minutus)* was 3.40 £/kg; Green-winged Teal was 3.57 £/kg; Little Crake *(Porzana parva)* was 4.76 £/kg; and Marsh Sandpiper *(Tringa stagnatilis)* was 5.23 £/kg (Meininger and Mullie 1981), compared to 4.00 £/kg for lamb; 2.20 £/kg for domestic rabbit and 2.85 £/kg for chicken. The wealthy have the financial liberty of buying domestic animals or the relatively more expensive wild birds, and in many cases they choose the latter. The other sector of modern Egyptian society that consumes wild birds is wildfowlers, who sell the animals to the wealthy, but retain some birds for their own use.

The wide range of opinion given by the taste-testing panel for some samples indicates that tremendous variation of opinion exists within each culture on the palatability of certain species and that cultural opinion is not directly related to the intrinsic taste quality of meat. Whether the low scores were a function of neophobia or the actual taste of the meat is difficult to say, but both factors may have played a role in forming opinions. Further, genetically inherited differences in the assessment of palatability may account for some variation in individual opinions. Inferences about variation in palatability between cultures are unfounded, since many different factors determine personal and cultural opinions of taste.

In the final analysis, it seems misleading to draw cross-cultural inferences on variations in the perceived edibility of given food items because so many factors, ecological and cultural as well as personal and collective, influence the human palate.

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BOOK REVIEW

Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity. T. Douglas Price & James A. Brown, eds. Studies in Archaeology. New York: Academic Press, 1985. Pp. xvii. 450. n.p. (hardcover).

The subtitle of this book is more accurate and indicative of content than the main title. This is not a book about hunting and gathering. Rather, it is a book about increasing complexity in the socio-economic and belief systems of prehistoric groups who may be classified as hunter-gatherers because they putatively depended largely on wild resources for their subsistence. Because it does not focus on subsistence systems themselves, readers primarily interested in the relationships between specific animal or vegetable resources and human cultures are likely to be disappointed. Most of the studies do not even consider the relative importance of animals, vegetables, and fish in the diet, let along the particular species exploited, the technologies involved in their exploitation, or the balance between calories received and energy expended in particular subsistence pursuits. What they do instead is concentrate on what hunters and gatherers do when they are not busy hunting and gathering. The results are stimulating and theoretically interesting for our total understanding of hunting-gathering lifestyles, and of the sources of cultural change and complexity.

The book grew out of a symposium on "Complexity among Prehistoric Hunter-Gatherers" at the XIth International Congress of Anthropological and Ethnological Sciences in Vancouver, BC, in 1983. Additional essays and discussions were included in the final volume. The purpose of the symposium and book are clearly set forth by the editors in the Preface (p. xiii):

> This is a book by archaeologists on the subject of culture change and complexity ... Our specific focus is on the emergence of cultural complexity among hunter-gatherers. We hope to point out that the traditional dichotomy of forager versus farmer has little significance with regard to the organizational development of human society—that means of subsistence do not dictate levels of cultural complexity. We intend to spotlight the variety of adaptations that characterize prehistoric hunter-gatherers ...

Participants considered such questions as the origins of intensified food procurement systems, sedentary communities, and social inequality or hierarchic organization, as well as the interrelationships of various factors leading to the elaboration of society.

The focus of both symposium and book was global. Essays in parts I and IV stress comparative models; those in parts II and III stress models and data for particular times and places. Essays in Part II deal with North America, focussing on Alaskan Eskimo, Northwest, Interior British Columbia, and Midwest examples. Those in Part III deal with the Old World, including the Upper Paleolithic of the Central Russian Plain and of Southwest France, ritual communication in Paleolithic Europe, the Mesolithic of Northwest Europe and of Southern Scandinavia, the Natufian of the Levant, and Australia. These essays make no attempt to present comprehensive reconstructions of prehistoric cultures in the given times and places; rather, they concentrate on models of and evidence for developing cultural complexity. Readers not intimately familiar with each area may find it difficult to judge the models and their supportive data without more general contextual information. Condensation and presentation in tables of general sequences as well as specialized data might have made for better understanding in some cases. In general, participants attempt to stress both data and theory in their essays. Partly because the data base varies from region to region, however, and partly because the postulated cultural systems are large and complex, most essays present more theoretical models than data. The book serves better as a source of provocative ideas than as a reference source for information about prehistoric hunter-gatherers in specific regions. It should also be noted by non-archaeologists that most of the cultural systems discussed are reconstructed from archaeological data and should thus be considered as hypothetical models for testing rather than field observations against which models are tested.

Within these limitations, the volume deals an effective blow to a cultural ecological approach which has become an almost subconscious part of archaeological thinking in the years since Julian Steward proposed his theory of culture change. Because ecofacts, artifacts, and spatial patterns make up much of our raw data in archaeology, it is very tempting to follow Steward's prescription of working from the environment, which lies outside the cultural system, through the environment-technology link to the core cultural elements most affected by this link, and thence to the "peripheral" elements which are less closely tied to subsistence. Because our reconstructions work this way, we have sometimes tended to assume that culture works this way, too. The argument that in some cases social or ideological factors are the prime movers in cultural dynamics and that the environment-technology link acts only as a secondary enabling factor

has been voiced strongly by Marxist scholars, some of whom are represented in this volume. An equally strong factor in creating discontent with traditional cultural ecological models, however, has been the shift from site-based to regional approaches in data acquisition. As many of the studies presented demonstrate, the idea of cultural adaptation to a specific set of resources is very seductive when a single social unit inhabiting a specific resource zone is the focus of study. When the focus shifts to a regional social-economic system spanning a number of resource zones, the model becomes less satisfying. The search for models which will deal with such regional systems, and the complementary search for data which will test these models, are the focus of most of the essays in the book. In general, they are successful in making strong cases for a degree of cultural complexity among hunter-gatherers which requires and supports new explanatory models. Several such models are proposed. Neither theoretical nor regional essays, however, pretend to offer final solutions. The aim was to point out the inadequacy of traditional models and data bases and to suggest new directions in the study of prehistoric hunter-gatherers. This aim has been admirably achieved.

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A HISTORY OF FUEL MANAGEMENT (A.D. 500 TO THE PRESENT) IN THE MANTARO VALLEY, PERU

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ABSTRACT.—We present evidence for a long history of active management of fuel resources by the inhabitants of a relatively tree-less high Andean Valley. Three types of information are used in this study: archaeological data of fuel remains from prehistoric sites, native and Spanish documents concerning aspects of 16th century fuel use, and an ethnographic survey of present fuel practices. Presently, fuel is managed by tree cultivation, use of a wide variety of fuel types including the by-products of crops and herds, rules for fuel collection, and cooking practices emphasizing its sparing use. These practices have great antiquity in the area; in pre-Spanish times the Inca controlled forests and the cultivation and cutting of trees and collected large quantities of fuel as tribute. Archaeological evidence indicates that fuel management may have begun before the Inca conquest of the area.

RESUMEN.—Presentamos evidencia de una larga historia de manejo activo de recursos combustibles por parte de los habitantes de un valle andino alto, relativamente desprovisto de árboles. En este estudio se usan tres tipos de información: datos arqueológicos sobre restos de combustibles recuperados de sitios prehistóricos; documentos indígenas y españoles refiriendo aspectos del uso de combustibles en el siglo XVI; y una encuesta etnográfica sobre el uso actual de combustibles. En el presente los recursos combustibles se manejan mediante el cultivo de árboles, el uso de una gran variedad de combustibles, incluyendo los subproductos de cultivos y rebaños, reglas para la recolección de combustible y procedimientos culinarios que enfatizan su uso frugal. Estas practicas son muy antiguas en la zona; en la época prehispanica el Inca controlaba los bosques y el cultivo y corte de los árboles, y colectaba grandes cantidades de combustible como tributo. La evidencia arqueológica indica que el manejo de combustibles puede haberse iniciado desde antes de la conquista incaica de esta área.

RÉSUMÉ.—Nous présentons les preuves d'une longue durée dans la direction active des resources combustibles chez les habitants d'une vallée des Andes ou on trouve assez peu d'arbres. Cette étude utilise trois categories d'information: les restes archéologiques des combustibles dans des sites préhistoriques, les documents Espagnols et indigénes sur l'utilisation des combustibles au 16 éme

siécle, et une étude ethnographique de l'utilisation contemporain des combustibles. Aujourdhui, les combustibles sont organisés dans la cultivation des arbres, dans l'utilisation d'une grande variété des formes des combustibles comme les restes de la récolte et des troupeaux, dans les réglements pour le receuil des combustibles, et dans les pratiques de la cuisine oú on souligne l'utilisation prudent des combustibles. Ces pratiques ont une grande antiquité dans la region; pendent l'ére pre-Hispanique las Incas controllaient les forêts et la cultivation et le coupage des arbres et ramassaient des grandes quantités des combustibles dans la forme de tribut. Le témoignage de l'archéologie indique que l'organisation des combustibles avait peut-être commencé avant la conquete de la region por les Incas.

INTRODUCTION

In the river valleys of the central Andes, natural fuel resources have long been scarce. The surrounding high plateaus are devoid of trees, and only a few small trees and bushes grow on the cold wet slopes and line the watercourses of the valleys. Yet large populations of people have lived and farmed in these valleys for millennia, periodically supporting such wide-spread phenomena as the Inca empire and Spanish colonialism. How have the people of these valleys managed their fuel resources over the centuries, and how have the valleys continued to support large populations in spite of the scarcity of fuel? In this paper we investigate the long-term history of fuel management in one Andean valley. Studying the dynamics of existing fuel-use systems is a basis for approaching the urgent ecological problem posed by the scarcity of fuel in many areas of the world today.

After an introduction to the Mantaro Valley, we begin with a survey of present-day fuel practices made there in 1985, which reveals that the inhabitants of the valley today manage their fuel by cultivating trees and by using a wide variety of fuel types from different elevational zones. The products of the anthropogenic landscape such as crop residues and animal dung are valuable fuels. Rules govern the collection of different fuel types, and cooking practices reflect sparing fuel use. In the second section, we discuss documents from the sixteenth century showing that many of these management practices are ancient; not only were there tree-planting programs and controls under early Spanish rule, but the evidence indicates that fuel and fuel management was also an important part of pre-Spanish Inca economy and policy. We can go further into the past through the use of archaeological evidence; in the third section of the paper we present a study of fuel remains from archaeological sites in the Mantaro Valley. We believe that the remains reflect Incaic fuel management policy. Furthermore, the pattern characterizing the Inca period is first evident in pre-Incaic times, in the households of Late Intermediate fortified towns of the fourteenth century.

THE MANTARO VALLEY AND ITS PEOPLE

The Mantaro Valley is a high intermontane valley in the modern province of Junín in the central Andes of Peru. The valley floor, bisected by the Mantaro

River, is 3200-3400 m above sea level, and is flanked by two high mountain ranges, the Cordillera Occidental on the west and the Cordillera Central on the east. The valley is about 60 km long and about 4-8 km wide. The data in this paper are mostly from the upper valley near the town of Jauja, including the small Yanamarca Valley to the north (Figs. 1 and 2).

The sharp relief of the area creates a gradient of biological communities. The valley floor receives about 700 mm of rainfall a year, falling mostly from September to March. Average daily temperature ranges from about 10°C to 12°C throughout the year. However, diurnal variation is great, especially in the dry

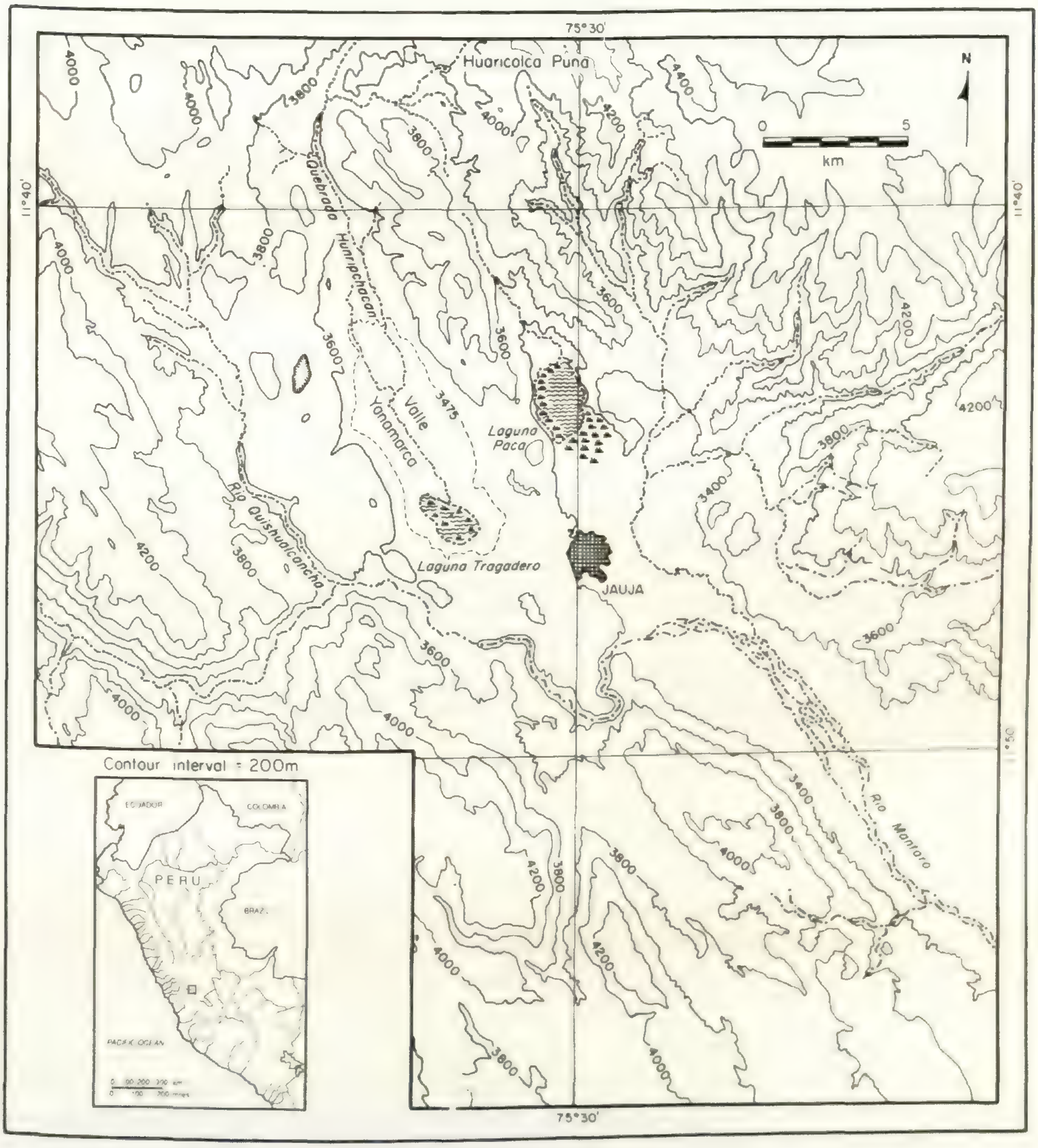

FIG. 1.—Map of the Upper Mantaro River Valley.

FIG. 2.—View across the Yanamarca Valley. Note the scarcity of trees except for cultivated eucalyptus in the valley bottom.

season between May and August when night frosts occur on the valley floor (Hastorf 1983, Mayer 1979). As elevation increases up the slopes of the mountains, conditions become wetter and colder. The modern plant communities will be briefly described, especially in regard to the available sources of fuel, following Gade (1975), Hastorf (1983), Mayer (1979), Tosi (1960), Pulgar Vidal (1967) and Weberbauer (1936, 1945).

The puna. The high cold plateau or puna above the valley (above 4000 m) supports no trees, being covered mostly with grasses, notably ***ichu*** (species of *Stipa* L. and *Festuca* L.). The plants of the puna serve as pasturage or cows, sheep, and camelids. The puna is sparsely populated with the scattered camps and small villages of herders.

The high slopes. The high slopes between 4000 and 3500 m are moist and cold, and are characterized by grassy steppes with scattered shrubs and small trees, mostly ***quinual*** (species of *Polylepis* Ruiz & Pav.) and ***quishuar*** (species of *Buddleja* L.), with some *aliso* (*Alnus jorulensis* HBK). On protected slopes people grow barley (*Hordeum vulgare* L.), ***tarhui*** (*Lupinus mutabilis* Swett), ***quinoa*** (*Chenopodium quinoa* Willd.), and the tubers ***papa*** (*Solanum tuberosum* L.), ***mashua*** (*Tropaeolum tuberosum* R. & P.), ***oca*** (*Oxalis tuberosa* Molina), and ***ulluco*** (*Ullucus tuberosus* Loz). The lower fields within this zone are step-slope terraces often edged with hedges, and the upper fields tend to be without hedges and have longer periods of fallow. These field systems provide fuel from the hedge shrubs and stalks of the threshed crops, and in higher areas, dung from animals grazing on fallow fields. Many of the peasants of the valley live in nucleated or dispersed villages in this zone.

The valley. The Mantaro River basin, tributary valleys, and lower alluvial slopes (3000-3500 m) comprise a temperate, semiarid zone, with intensive settlement and agriculture. Almost all of this zone is under cultivation, with field of maize, wheat, ***quinoa*** (*Zea mays* L., *Triticum* spp., *Chenopodium* spp.), legumes, fodder crops, fruits and vegetables. Trees grow on the edges of fields and in groves; the most common is the cultivated introduced eucalyptus (*Eucalyptus globulus* Labill). The *guinda* (the introduced cherry *Prunus avium* L.) and the native *aliso*, ***quinual*** and ***quishuar*** are also planted (Adams 1959, Dickinson 1969, Mayer 1979). In waste areas and ravines there is abundant growth of woody shrubs such as ***chilca*** (species of *Baccharis* L.), *retama* (an introduced shrub, *Spartium junceum* L.), and ***pactae*** (species of *Cassia* L.). ***Chaghual*** (the Mesoamerican maguey, *Agave americana* L.) also grows here and is used for fuel.

The ceja de la montaña. Another biological community available to the inhabitants of the valley is the cloud forest or *ceja de la montaña* on the eastern slopes of the Andes, some 30-40 km from Jauja. Here, the warm and humid conditions support a dense forest including species of *Weinmannia* L., *Cedrela* (P. Br.) L., the coniferous *Podocarpus* L'Her., and many other arboreal taxa. The higher slopes are much disturbed, and secondary growth is typically the bamboo-like grass *carrizo* (*Chusquea serulata* Pilger), shrubs, and small trees typical of higher elevations such as *Alnus jorulensis* and species of *Buddleja* and *Escallonia* Mutis. To the inhabitants of the Mantaro Valley the *ceja* has since prehistoric times been an important source of products of the tropical forest, especially ***coca*** (*Erythroxylum coca* Lam.) (Hastorf 1987).

The landscape of the Mantaro valley has been greatly affected by thousands of years of occupation by herders and farmers. The extent of this effect has been debated; many researchers argue that the Andes were originally forested and have been deforested by human activities (Ansión 1986, Budowski 1968, Cook 1916, Dollfus 1981, Guillet 1985, Venero and Macedo 1983). Investigations of glacial history in the Mantaro have revealed that periodic climatic fluctuations were of sufficient magnitude to change the elevational range of the vegetation zones (Seltzer and Hastorf, in press). It is likely that human and climatic factors have interacted in shaping the landscape. The anthropogenic landscape is probably a very old one, perhaps initiated by increased camelid grazing in the Junín puna by about 1500 B.C. (see Rick 1980).

The inhabitants of the valley today, a population of some 500,000 (Aliaga 1985:7) live in towns, villages, scattered households, or in the provincial capitals of Jauja in the north and Huancayo in the south. Farming is the major occupation in the valley; employment also includes mining, commercial farming, and light industry (Aliaga 1985, Mayer 1979). Spanish is the common language with only a few people still speaking Quechua.

The indigenous ethnic group of the Upper Mantaro Valley are the Wanka, who have been farmers and herders in the area for at least 2500 years. They were known as the Wanka by the Inca who conquered them in A.D. 1460,

and archaeological evidence indicates ethnic continuities far into the past (Hastorf *et al.* 1989).

Archaeological investigations (D'Altroy 1981, Hastorf *et al.* 1989, LeBlanc 1981, Matos and Parsons 1979, Parsons 1976, Parsons and Hastings 1977) have shown that until about A.D. 1300 the people lived in many small settlements scattered across the valley floor and up the sides of the mountains. They herded camelids and grew many of the same crops as today: maize, ***quinoa***, tubers, and lupines. About A.D. 1300 there was a considerable demographic (and presumably social and political) change; population increased and people began to live in fewer, larger towns, often built on hilltops and surrounded by fortifications. This era, evidently one of warfare among several polities in the valley, ended ca. A.D. 1460 when the Wanka were conquered for the Inca Pachacuti by his general Tupac Yupanqui. Under the *pax incaica,* the Wanka were resettled in smaller towns on the valley floor.

At the time of Spanish conquest, the Wanka sided with the Spanish against their Inca overlords, providing the Spanish with labor and supplies. They were again resettled in the 1570's, when the viceroy Francisco de Toledo ordered the *reducciones,* a movement of the people from scattered settlements into colonial towns. Due to the Wanka alliance with the Spanish, the *hacienda* system never took hold in the valley and land stayed largely in the hands of the Wanka people (Aliaga 1985, Espinosa Bravo 1964).

After recovering from the effects of the Spanish conquest and civil wars, the Valley re-established itself as a center of agricultural production and mining. Economic trends in the last centuries have been increasing participation in a cash economy, and a shift in land tenure from a traditional usufructory group use to private ownership (Aliaga 1985, Mayer 1979). The change in economy is such that now in the Mantaro a reasonably steady source of cash is necessary to survival (Mayer 1979).

PRESENT-DAY FUEL USE: FIELD STUDY EVIDENCE

In the 1980s, the Mantaro Valley is still inhabited by Wanka people who are largely farmers and herders. An idea of the present-day pattern of fuel-use was obtained by a series of interviews with people of the valley made by Christine Hastorf and Lynn Sikkink in the summer of 1985. Fifteen interviews were made with people collecting or processing fuel or travelling on the roads in and around the Jauja valley. Questions were asked about types of fuel used, fuel preferences, collection practices, and cooking and hearth use (see Appendix 1). Although the sample of interviews is small, the patterning of the responses (Tables 1 through 3) indicates a general consensus in present practices.

Fuel use and preference.—People were asked what types of fuel they burned and in what proportions. Categories asked about were firewood *(leña),* dung *(guano),* straw *(paja),* cobs *(mazorcas),* and other *(otro)* (Table 1). The categories in the questionnaire are those in common use; at least four additional fuel categories

TABLE 1.—*Responses to questions on kinds of fuel and their relative use.**

Categories	Types	Probable taxon referred to**
Firewood (14)	eucalyptus (13)	(*Eucalyptus globulus* Labill)
	aliso (3)	(*Alnus jorulensis* HBK.)
	quinual (3)	(species of *Polylepis* R. & P.)
	pactae (2)	(species of *Cassia* L.)
	jiljil (1)	(?species of *Berberis* L.)
	chaile (1)	(?)
	taraca (1)	(?*Sambucus peruviana* HBK.)
Dung (13)	cow and sheep (1)	
	cow (1)	
	''of the countryside'' (1)	
Straw (11)	''of the fields'' (3)	
	''of the mountains'' (1)	
	quinoa (1)	(*Chenopodium quinoa* Willd.)
	habas (1)	(*Vicia faba* L.)
Maize Cobs (4)	''sometimes'' (3)	
Other (7)	chilca (3)	(species of *Baccharis* L.)
	pactae (2)	(species of *Cassia* L.)
	kerosene (2)	
	retama (1)	(*Spartium junceum* L.)
	tantal (1)	(species of *Citharexylum* (Juss) L.)
	charcoal (1)	

*numbers in parentheses are the number of times a particular category or type was mentioned as being used, out of 15 interviews. Some people did not name particular types of material under a general category; some people named several types. For example, thirteen people said they used dung, but only three defined the kind of dung; some of the seven people who said they used ''other'' fuels mentioned several types.

**actual plant material was not shown at the time of the interviews; the scientific taxon is that to which the common name generally refers in the area; confirmation can be seen on identified vouchers for the reference collection including common names given by local guides at the time of collection.

emerged from the interviews (see below). In general, people said they used a combination of firewood, dung, and straw for fuel. About half the people said they used firewood most often, and about half said dung was most frequently used. Straw is also in frequent use, mainly to get the fire started. Maize cobs were seldom mentioned.

Table 1 lists the specific types of fuel mentioned under the general fuel categories. In the category firewood, eucalyptus was mentioned first by almost

TABLE 2.—*Fuel use vs. fuel preference.**

Rank Order	Firewood	Dung	Straw	Kerosene	Charcoal	Shrubs	Cobs
1	6(9)	6(1)	1(1)	1(1)	(1)		
2	4(2)	4(3)				1(1)	
3		(1)	3			(1)	
4							1

*numbers are the counts of responses of a category in a rank-order; numbers not in parentheses are for *use;* and numbers in parentheses are for *preference,* e.g., six people ranked firewood as the primary fuel used, and nine people ranked it as the primary fuel preferred.

TABLE 3.—*When and where fuel is obtained.**

Category	When**	Where
eucalyptus	yearly (10)	bought (6) own land (3)
other firewood and shrubs	daily (5) weekly (1) monthly (1)	mountains (2) low slopes (1) ravines (1) valley (1)
dung	daily (10)	fields (5) corrals (5) mountains (2) puna (2) ''anywhere'' (2)
straw	daily (5)	fields (2) ''anywhere'' (2) mountains (1)

*numbers in parentheses are the times that particular response was given (out of fifteen interviews). The number of responses under ''where'' do not necessarily add up to the number under ''when,'' since people sometimes named several places (or none) when asked where they obtained that particular category of fuel.

**collection of shrubby wood, dung, and straw occurs most frequently in the dry season.

everyone interviewed. Additional types of firewood mentioned by at least two people were *aliso, **quinual,*** and ***pactae***[1]. The dung used is from cows and sheep, although sheep dung is not as suitable and is used less often. Responses in the category straw can be subdivided into two groups of annuals; i) naturally-occurring grasses of the mountains, and ii) crop stalks such as ***quinoa*** and *habas.*

A number of fuels were named under "other." These included two additional categories of material bought in the market, kerosene and charcoal. Also mentioned were woody shrubs such as ***chilca,*** *retama,* and ***pactae.*** Evidently these shrubby types are perceived to be in a category other than *"leña,"* presumably because they have small thin branches. Apparently the category *"leña"* can be subdivided into i) logs or split sections of logs (also called *rajadas de madera)* from the trunks or large branches of trees, and ii) small-diameter sticks or brush from shrubs and bushes. Note that one taxon, ***pactae,*** was mentioned in both these categories (by different people); it is unclear whether they meant different parts of the same plant or whether the categories overlap in some way *(leña* may be an inclusive term).

A second set of questions concerned fuel preferences. People were asked to rank the fuel categories they used in order of use and of preference. Table 2 compares the rank-ordered responses for the categories firewood, dung, straw, kerosene, charcoal, shrubs, and cobs. The table shows that the major difference beween use and preference is that while firewood is the number one *preferred* fuel by most people (dung is given as first choice only once), dung is in fact *used* most often in about half the cases.

Obtaining fuel.—The interviews indicate considerable differences between the main fuel categories in when, where, how, and by whom each is obtained (Table 3). The main fuelwood, eucalyptus, is cultivated, mostly on good land on the valley bottom. Most people obtain eucalyptus wood once a year in the span of a few days, and then store it for the year. One to four trees are bought, cut, and hauled home, or cut on a person's own land. This is primarily a male task. Eucalyptus, for those who can buy or have land to grow it, is a staple fuel in the wet season. To augment this supply shrubby woods are collected daily or weekly (less often in the rainy season) from the hills, lower slopes, and ravines. One woman said she walked three hours everyday to get wood, another reported one to two hours, and another an hour a day. Dung is collected daily in the corrals, fields, on the puna or anywhere it can be found. Four people said dung collection was done mostly in the dry season, because it needs to dry for a week before use (Fig. 3). One person said dung collection took about an hour a day, and another said dung was collected during other errands. Straw or grasses and weedy plants are also collected daily in the fields or pastures during the dry season. Two boys who were interviewed coming down into the valley with bundles of grass said they went everyday to the hills to collect. At harvest time, all crop straw is saved either for fodder or fuel.

Use of the hearth.—There was little variation in responses to questions about how people used their hearths. Most people said they light their hearths twice a day for cooking, once in the morning and once in the afternoon. One person said it was lit only once a day in the afternoon. The hearth is not generally used to provide warmth, although two people said their fires were going all day. The hearths are most often swept and emptied every morning, the ashes being thrown

FIG. 3.—A woman putting dung to dry on her roof. (Photo courtesy of L. Sikkink)

onto a waste pile (locally called *guano de corral).* These piles are left to compost and are then used for fertilizer (Sikkink 1988). The ashes from the hearth are considered valuable field fertilizer by everyone asked. The pattern mentioned most frequently is that the *guano de corral* pile is taken to the fields once a year at planting time. Potatoes and fava beans are the two crops named that receive the ashes.

Summary and discussion.—A number of points about the nature and use of fuel emerge from the interviews. First, getting fuel in the Mantaro Valley is expensive in time, labor and/or cash, and fuel is used sparingly. For those without sufficient cash, considerable daily labor is expended in getting fuel, mostly by women and children, although men cut eucalyptus and collect fuel when out on other errands. Most people light their hearths only for cooking meals, which are generally soups and stews that can be boiled in a single pot over a small fire. Nor does fuel use end with cooking; the ashes are afterwards used as field fertilizer. Fuel use studies elsewhere in the Peruvian Andes also indicate this sparing use of fuel, but add that at times of feast or fiesta, fuel, as well as food and drink, is used lavishly (Ansión 1986, Skar 1982).

The assemblage of fuels used is varied, including several kinds of wood, kindling, dung, grass, weedy plants and crop residues. This variability is probably related to the relative scarcity of fuel; Skar (1982) found that in Andean communities where fuel is relatively abundant only the preferred fuels, wood and kerosene, were used, while where fuel is scarce people resort to a greater variety.

The categories of fuel used correspond to categories in long use. To the catgories firewood, dung, straw, and cobs, people added charcoal and kerosene, and also made a distinction between logs and sticks, and between grass "of the mountain" and crop straw. These categories, with the exception of kerosene, correspond to those seen in the Mantaro Valley *quipu* records from the time of the Spanish conquest and also in sixteenth-century written accounts (see below).

Many of the fuel types used are products of the anthropogenic landscape—cultivated trees or the by-product of crops or domesticated animals. In other words, people produce much of the fuel they use.

The acquisition of fuel in the Mantaro Valley forms a complex pattern with varying seasonal and economic aspects. Fuel collection and use varies throughout the year; daily collection of dung, small sticks, and grass to augment the eucalyptus supply is a dry season pattern. Crop residues also provide additional fuel during the dry season. This indicates that less time but more cash are needed for fuel in the rainy season.

Economic and land-use factors also contribute variability to the fuel pattern. Today's "ideal" Andean fuel, eucalyptus, is a cultivated cash crop available only to those who have cash or land. In the Andes, planted trees are the personal property of those who plant them (Sherbondy 1986). Shrubs and kindling however can be gathered from hills and ravines. Here use rights are traditionally communal, as is firewood land in the Marañon Valley to the north (Brush 1977:77), but with increasing privatization these rights may be curtailed. For example, Skar (1982) found that Peruvian cooperatives controlling land are beginning to demand payment from neighbors for pasturage and wood collected while pasturing; people are indignant about this since they consider collecting wood their right. Dung, straw, and weedy plants are more readily available. In the Jauja region, while only the owners have the rights to dung or straw from their corrals or fields in crop, anyone may collect dung and straw from the communal grazing lands of the upper slopes and the puna, and from fallow fields.

The adoption of eucalyptus has had a major impact on the fuel-use patterns and landscape of the Mantaro Valley. In 1911 and 1920, the first plantings of eucalyptus (*Eucalyptus globulus* Labill.) were made in Muquiyauyo near Jauja (Adams 1959), some 50 years after its introduction to Peru from Australia (Soukup 1980-87:177). Since then, eucalyptus has spread rapidly throughout the valley, replacing the indigenous trees in preference and planting (Dickinson 1969). Eucalyptus first was planted as a dooryard tree and a field border, and fulfilled only local demand, but commercial demand for the wood in the 1940s greatly increased production. Irrigated fields in the best crop land are now solid-planted in eucalyptus (Dickinson 1969). In 1969 the valley contained some 12 million eucalyptus trees (Soukup 1980-87:177). This cash crop is a favorite fuel and has brought fuel into the cash economy.

HISTORIC FUEL USE: DOCUMENTARY EVIDENCE

For a look at fuel use in the Mantaro Valley in the sixteenth century, we turn to the documentary evidence. The first Spanish view of the area comes from

Miguel de Estete, one of the small band that first entered the Mantaro Valley in March 1533, who wrote:

> The town of Xauxa is large and is in a very attractive valley, and the land is temperate; a strong river passes by one part of the town. It is abundant in supplies and herds; it is made in the manner of a town in Spain . . . (Estete 1917 [1532-1533]:96)

The valley was partitioned into three Inca administrative units or *saya;* Hatunxauxa at the north end, Lurinhuanca in the central part, and Ananhuanca to the south. Estimates of the valley's population at the time of Spanish entry range from 135,000 (Rowe 1947) to 243,000 (Smith 1970).

Lining the hillslopes behind Jauja and for the length of the valley were thousands of Inca state storehouses, or ***qollqa*** (D'Altroy 1981). These ***qollqa*** contained massive stores of subsistence and luxury goods, and the quantities were recorded by officials on ***quipu,*** a mnemonic system of knotted strings. The Wanka supplied the Spaniards with goods for much of their campaigning, and in 1561, the ***quipu*** records of these supplies were presented by the Wanka leaders for restitution at the *Audiencia de Los Reyes* in Lima. These records have been published by Espinoza Soriano (1971) and discussed by Murra (1975), D'Altroy (1981), and D'Altroy and Hastorf (1984). The contributions from the Wanka included large quantities of fuel, along with other goods such as animals, maize, potatoes, cloth, and ceramics. The ***quipu*** records tell the categories of fuel, the quantities donated, the event occasioning the donation, and by which ***saya*** the material was contributed (Table 4). These records contain several points of interest in regard to fuel-use in the Mantaro Valley at the time of Spanish contact.

First, fuel was a considerable article of tribute, indicating its valuable role in the economy. The contents of the ***qollqa,*** especially the food and fuel, were used to support state personnel, supply labor projects and the military, and for the support of the community (D'Altroy 1981, Morris 1967).

Second, the ***quipu*** reveal the linguistic categories used for fuel. Each string of a ***quipu*** corresponded to a category of goods for tribute. The categories of fuel were always listed together and in the following order: string 28, *leña rajadas;* string 29, *leña menuda;* string 30, *carbón;* string 31, *hierba;* and string 32, *paja* (Murra 1975). These categories in Spanish were those transcribed at the *Audiencia* from the Quechua readings given by the ***quipu*** officials. D'Altroy (1981) translates the categories as "coarse firewood," "fine firewood," "charcoal," "grass," and "straw," respectively. The inclusion of charcoal in the 1533 records indicates that it was an indigenous category (although this has been debated, see Ansión 1986:38), since large quantities were already stored in the Mantaro storehouses at the time of Spanish contact. The existence of a sixteenth century Quechua word for charcoal, ***quillimca*** or ***sansa,*** (Holguin 1952 [1608]:308, 447) is additional evidence for prehispanic charcoal-making in the Andes. Dung is not one of the ***quipu*** categories. Camelid dung may have been a fuel category, but perhaps in household use only.

TABLE 4.—*Categories and quantities (in cargas or loads) of fuel given to the Spanish by the Wanka, 1533-1537, from* ***quipu*** *records.**

Event		split logs *saya*** *leña rajada*	kindling *leña menuda*	charcoal *carbón*	grass *hierba*	straw *paja*
Pizarro arrives in Jauja, 1533.	L	360,377	—	56,862	—	—
	H	200,071	30,404	—	48,989	321,354
Treasurer Requelme in Jauja 1533-34	L	35,693	—	—	—	—
	H	28,076	8,665	—	12,112	6,145
Pizarro returns from Cuzco	L	59,655	—	—	—	—
	H	30,110	—	—	9,485	10,111
After the campaign against Quizquiz	L	44,394	—	—	—	—
	H	24,074	1,213	—	8,915	11,123
Campaign against Quizo Yupanqui	L	4,400	—	—	—	—
	H	2,200	—	—	10,134	10,133
Alvarado received 1537	L	—	—	—	—	—
	H	17,000	232,203	—	34,220	11,113

*from Murra (1975: Table IV) and D'Altroy (1981: Table 7.2).
***saya* were the Inca administrative units into which the Mantaro Valley was divided: L = Lurinhuanca; H = Hatunxauxa.

The third revealing aspect of the ***quipu*** rcords is the quantity of fuel material stored in the ***qollqa.*** In the five years from 1533 to 1537, the two northern ***saya*** of the Wanka contributed more than one and a half million loads of fuel to the Spaniards (1,629,231 *cargas).* Most of this (1,018,057 *cargas)* was donated in 1533 when Pizarro arrived; presumably the fuel holdings of the storehouses at this time exceeded this. This means that over the five years an average of 325,000 loads per year (minimally) and 893 loads per day entered the storehouses. We don't know the size of the *cargas* stored in the ***qollcas;*** they may have resembled those drawn by Guaman Poma (Figs. 4 and 5). In the present-day Andes, a bundle the size of one's back, called a *fardo,* weighs ca. 25–30 lbs; these loads are also called ***ch'ipa*** (two ***ch'ipa*** can be carried by a llama) (Guillermo Delgado, *pers. comm.).* This would mean that a daily average of over 22,000 lbs of logs, kindling, grass, and straw entered the storehouses, to say nothing of what the people gathered for their own use. It is likely that some degree of fuel management would be necessary to sustain this level of fuel harvest.

In spite of the large quantities of fuel donated by the Wanka, in addition to that which they doubtless took for themselves, the Spaniards perceived the supply of fuel in the Mantaro as sparse and as one of the factors curtailing their settlement in Jauja. In 1582 Juan de Henestrosa wrote in a report from Jauja province for the *corregidor* of the province, Andres de Vega:

> . . . the first Spanish Town that Francisco Pizarro established was in the tambo of Hatun Xauxa, and they were settled there for two years, and because it seemed to them that there was a lack of firewood in this valley and of irrigation water to make fields and other plantings, they agreed to leave to settle in the valley of Lima ...
>
> (Henestrosa 1965 [1582]:170)

The apparent scarcity of fuel, or at least of wood, in the Mantaro Valley is alluded to again in the report, in a passage that also gives some idea of the landscape and of fuel sources and management at the time:

> . . . in this valley there are not more than two kinds of trees of the countryside; one is aliso *[Alnus jorulensis]* and the other is ***quixuar*** *[Buddleja],* as it is called by the Indians; and this is planted by hand and brought in from outside for use in their houses and church buildings, so that with effort enough wood can be found for them . . .
>
> (Henestrosa 1965 [1582]:171)

This passage was written 50 years after the conquest and about a decade after a major resettlement. At this time the population was much reduced; the 1582 reports records a population for the Mantaro (an estimated 60,000) of less than

FIG. 4.—Old men and young girls as fuel gatherers (Guaman Poma 1987 [1615]: 190, 218).

FIG. 5.—Firewood and grass as a gift cementing kinship ties (Guaman Poma 1987 [1615]:918).

half what it had been in Inca times (an estimated 135,000)[2] (Henestrosa 1965 [1582]:167). If the people in 1582 had to plant trees and import wood, plausibly they also did in Inca times when the population level was more than twice as high and there were also high tribute demands for wood.

There is evidence indicating that fuel management, especially in the form of tree-planting, was an essential indigenous Andean practice. Sherbondy (1986) discusses the Quechua word ***mallqui,*** meaning a cultivated tree in distinction from trees that grow wild, called ***sacha.*** She points out that the rich terminology in Quechua concerning tree-planting indicates the antiquity of these practices. The following list from Holguin's sixteenth-century Quechua dictionary illuminates those practices:

> ***mallquini*** to plant or transplant.
> ***mallquipani*** to replant.
> ***Ppitticta cassacta mallquipani*** to transport trees to where they are lacking.
> ***Mallquiscca*** something planted.
> ***Mallqui mallqui*** plantation or grove of fruit-bearing trees.
> ***Mallquiçapa muya*** orchard of fruit-bearing trees.
>
> (Holguin 1952 [1560]:224-5)

Tree-planting and forest management seem to have been a concern of the Inca (see further discussion in Ansión 1986, Sherbondy 1986). Pachacuti Yamqui, a native chronicler, wrote this about the 7th Inca Viracocha Inca Yupanqui

> . . . they say that he was very gentle; his occupation was to build houses, and the fortress of Sacssaguaman, and also the fields and the planting of alisos *[Alnus jorulensis]* and other plantings of quishuar *[Buddleja* spp.] and chachacoma *[Escallonia* spp.] and molles *[Schinus molle* L.] . . .
>
> (Pachacuti Yamqui 1950 [1613]:236)

Polo de Ondegardo (1917 [1567]:80) wrote that in areas with a shortage of firewood the Inca set forests aside for himself that were called ***moyas*** of the Inca—the towns within whose boundaries the forests were could use them according to need, but only with order and license from the Inca. Fray de Murua lists among officials appointed by the Inca those who plant and take care of trees ***(''malqui camayos'')***, and states that one of the ordinances that the Incas gave to their vassals was that nothing should be harvested from planted or grafted trees until the fourth year (Murua 1964 [ca. 1600]:87, 89). There may also have been a somewhat stronger prohibition issued by the Inca: Guaman Poma (1987 [1615]:179) wrote that an ordinance of the Inca stated that no fruit-tree, woodlot (*''madera aomente''*; literally, augmented wood) or straw shall be burnt or cut without proper authority, on pain of death or other punishment.

The documents also reveal aspects of traditional fuel use, including details as to its collection, use in cooking and high value as a resource. Getting firewood was one of the major tasks of life, as this scolding of a lazy person suggests:

> . . . you don't work in your field, you don't watch your llamas, or fetch dung, or firewood or straw, or finish anything, or weave to earn a living, lazy one.
>
> (Guaman Poma 1987[1615]:950)

Collecting fuel (firewood and straw are mentioned) was primarily the task of young girls (ages 8-12) and old men (between about 60 and 80) (Fig. 4). The drawing on the left of Fig. 4 of the old man carrying wood is captioned ''the conveying of tribute that serves the chiefs'' (Guaman Poma 1987 [1615]:190, 218). In October, in preparation for the rainy season, firewood was cut and piled up and put away for the winter; and straw *(''paxa'')* was also stored up. In November people also accumulated firewood and piled itup in their houses ''for themselves and for their principal people and ***curacas*** [local chiefs] and for the ***mitas*** [labor exchange projects] and for the whole winter'' (Guaman Poma (1987 [1615]:1233-7).

The categories of fuel mentioned in these early writings are those that appeared in the ***quipu;*** for example, as in a passage that also shows the Indian duty of providing fuel to the Spanish:

> And thus to the said caciques . . . the Indians are made to betake themselves with their firewood *[''leñas'']* and straw *[''paxas'']* in the

> mornings; in the afternoons as usual, obedience and law and Christianity. And whoever doesn't do it is punished. And they have to carry dung *[''estiércol'']* and firewood *[''leña'']*, straw *[''paxa'']*, grass *[''yerua'']* to their house and spin as they walk along the roads.
>
> (Guaman Poma 1987 [1615]:913)

The possession of abundant firewood was a sign of prosperity. Of town mayors it was said ''they have much firewood and straw and many fields'' (Guaman Poma 1987 [1615]:852). In the houses of the Inca, among other objects made of gold and silver such as maize plants, flowers, and birds, were ''heaps and piles of firewood logs, imitating the natural, as if they had been put there for use in the service of the houses'' (Garcilaso de la Vega 1985 [1609-1617:215). Firewood is often equated with food and water in importance as a resource; for example, as in this work of mercy:

> Your fire, Christian, is for God, your water is for God, your firewood is for God and your food is for God . . . Pity the crippled, lost and old Indians who have nothing to eat nor anyone to give them water [and] firewood.
>
> (Guaman Poma 1987 [1615]:914)

Fuel was used like food and other goods in reciprocal social and kin relations: the drawing shown in Figure 5 illustrates that in-laws have a duty to provide for each other; here a man presents a gift of firewood *(''lena'')* and straw *(''paxa'')* to his in-laws on the occasion of a death in the family (Guaman Poma 1987 [1615]:918). Firewood even had a place in the Inca wedding ceremonies; logs of firewood were gilded so that they looked like solid gold (Murua 1964 [ca. 1600]:67). At more typical weddings, Murua (1964 [ca. 1600]:70-71) recounts that the Indians brought the bride gifts of meat, coca, and ''firewood of some roots called ***Urutne*** [?], or if they didn't have that, of *aliso,* made into logs, and if they didn't have any of their own, they requested some from their cacique.'' This suggests i) that the type of wood burned had symbolic significance, and ii) that local leaders had some control over sources of wood.

Domestic fuel use was evidently limited to cooking; meals were cooked twice a day and most food boiled as soups, stews, and *mote* (boiled maize) (Guaman Poma 1987 [1615]:926, Horkheimer 1973). Cooking practices, and hence fuel use, were associated with units of time: ***huc yanuy chica*** was defined as ''one hour which is what it takes to cook a stew,'' (Holguin 1952 [1608]:365).

In contrast to the sparing household use of fuel was its lavish use in ceremony. Some of wood collected as tribute under the Inca went for this purpose; Polo de Ondegardo recounts (1917 [1571]:87-88) that a kind of red firewood was brought to Cuzco from 200 leagues away in the form of carved and decorated logs—these were brought in great quantities to burn in the sacrifices to the Sun and in the fires that burned in the plaza in the presence of the Inca and his mummified ancestors.

It is likely that the Spanish occupation brought about some changes in the traditional pattern of fuel use. The per capita need for fuel probably increased. Padre Cobo commented in 1639 that the Spanish were very wasteful in their use of fuel: he said that a Spanish household will use in a day fuel that would last an Indian household a month (Cobo 1891-1893 [1639]:Vol. 2, Libro 6:6-9). An earlier chronicler, Garcilaso de la Vega (1985 [1609-1617]:345) notes that most of the abundant *molle* trees (presumably encouraged or cultivated) near Cuzco were cut down in short order after the Spanish arrived because they made such good charcoal. The Spanish had new uses for fuel that consumed large quantities; in mining, lime and brick kilns, and bread ovens (see Ansión 1986, van Dam 1986), as well as new grazing animals that cleared new areas and prevented the reestablishment of woody growth. The dearth of wood and fuel was quickly felt in areas of high population, and near Lima and Cuzco measures were taken to counteract it. In Lima in 1551 a program of planting trees and ordinances governing the cutting of trees and use of fuel were instituted (Jiménez de la Espada 1965, Vol. 1:123). People who owned land were ordered to plant trees, and penalties were imposed on Spaniards and Indians for making charcoal, cutting or girdling trees, and using large logs in ovens.[3] In 1590 a program was instituted to reforest 60 km of the valley near Cuzco; 2400 trees were planted by the various *allyu* (community kin groups) under the direction of the Spanish. Trees of four taxa were planted: *Buddleja, Escallonia, Alnus,* and *Polylepis* (Sherbondy 1986).

In the sixteenth century, as in the twentieth, fuel was a valuable and tended resource in the Andes, as reflected in the cultural practices of tree planting, forest management, its collection as tribute and its social and ceremonial roles. In the Mantaro Valley, we have seen that in the 1580s *Buddleja* was planted and wood was imported from outside the valley. These practices were not limited to post-conquest times; the evidence indicates that tree cultivation, forest management, and wood importation were part of Andean life in Inca times as well. Whether these practices were exclusively Inca policy, or more essentially Andean and therefore likely to predate the Inca conquest in the Mantaro Valley, is a question to be addressed through archaeological evidence.

PREHISTORIC FUEL USE: ARCHAEOLOGICAL EVIDENCE

Archaeological sites in the Mantaro Valley are numerous and range from scattered hamlets of the Early Formative to large nucleated Late Intermediate towns and Inca period villages and administrative installations. The members of the Upper Mantaro Archaeological Research Project have excavated the remains of house compounds at a number of Late Intermediate and Inca period sites as well as earlier deposits at the stratified site of Pancân (Earle *et al.* 1980, 1987; Hastorf *et al.* 1989). From these house contexts we have direct evidence in the form of fuel remains from a thousand years of prehistoric fuel-use. These plant remains have been preserved by charring in antiquity.

During excavation of these sites, soil samples for flotation were systematically collected from each unit and context. The samples analyzed for this study (both

screen and flotation samples of 6 liters of soil) are from the four levels of Pancán, the two earliest of which date to the Early Intermediate (A.D. 450-700) and the two upper to the Middle Horizon and early Late Intermediate (A.D. 700-1300); from seven house compounds of the Late Intermediate Wanka II phase (A.D. 1300-1460); and from five house compounds dating to the Inca period (Wanka III phase, A.D. 1460-1532) (Table 5). Samples were chosen from uncontaminated midden, floor, and hearth contexts from all time periods. Samples from clear cases of catastrophic burning (i.e. burned houses) were excluded from the analysis, since the woody material in these samples may represent construction rather than fuel materials. We are assuming that the types of woody remains recovered most commonly and from wide distribution in middens, floors and ash dumps are most plausibly the result of intentional burning, i.e. fuel use (Smart and Hoffman 1988). Even if the primary use of the material was in manufacture (e.g. discarded tool handles, posts, bedding, mats), their charred condition indicates a secondary use as fuel.

TABLE 5.—*Chronology of Archaeological Fuel Remains.*

Provenience*	N of Samples	Phase	Period	Dates (A.D.)
J2=1,2; J54=2; J74=1,2	74	Wanka III	Inca	1460-1532
J7=2,3,7; J2=4; J41=1,5,6	117	Wanka II	Late Intermediate	1300-1460
J1, Level 1	53	Wanka I	Late Intermediate	1000-1300
J1, Level 2	36	Wanka 0	Middle Horizon	700-1000
J1, Level 3	19	Huacrapukio II	Early Intermediate/ Middle Horizon	450-700
J1, Level 4	28	Huacrapukio II	Early Intermediate	450-700

*site names and components: J1—Pancan (multicomponent HII-W1); J2—Hatunmarca (WII and WIII); J7—Tunanmarca (WII only); J41—Umpamalca (WII only); J54—Marca (WIII only); J74—Chucchus (WIII only).

In all, we analyzed 47 samples from Pancán levels 3 and 4, 89 samples from Pancán levels 1 and 2, 117 from Wanka II contexts, and 74 from Wanka III (a total of 327 samples). A total of 7996 woody fragments were recovered from the 327 samples, and 3670 of these were examined. The fuel remains from the Pancán site were analyzed by Greenlee (1988), the later material by S. Johannessen.

The procedures followed in the identification of the woody material are described by Pearsall (1989:155-165). All woody and stem materials were removed from the samples, which also included abundant food remains (Lennstrom 1988). A maximum of 20 fragments (some samples contained fewer than 20 fragments) were randomly selected for examination from the total fragments over 2 mm in

size. The remains fell into three general categories: "wood" (mature wood with growth ring pattern clearly distinguishable); "stem" (immature dicotyledonous wood, twig or stem); and "grass" (monocotyledonous stem, i.e. from grasses, rushes, etc.). The monocot and dicot stem fragments were predominantly complete cross-sections of small diameter (≤ 0.5cm). These two categories were not further identifiable. The mature wood fragments were compared to specimens in a reference collection of charred wood from 88 taxa of common Andean trees and shrubs.[4] The internal anatomy of the fragments was examined under 10X-70X magnification in transverse, radial, and tangential section, and details of the size and arrangement of the vessels, rays, and parenchyma were drawn and described (Core *et al.* 1979, Panshin and de Zeeuw 1970). One-to-one comparisons were made of the archaeological fragments to charred specimens in the reference collection.

In addition to wood, stem, and grass fragments, dung and maize cob remains present in some samples may represent fuel sources. The dung of grazing animals is an important source of fuel in the Andes (Winterhalder *et al.* 1974), but it is scarce in the Mantaro samples. This could be due to poor preservation of this material; however, in the earlier Pachamachay site (ca. 2000 B.C. to A.D. 500) just north of the Mantaro in the Junín puna, charred dung remains were commonly recovered from flotation samples (Pearsall 1980:211). Thus camelid dung may not have been a primary fuel source in the Mantaro Valley sites, although it was apparently more heavily used on the nearby puna in earlier times. Maize cobs, an occasional fuel in the present-day Mantaro, are represented in the samples in the form of charred cupules. We cannot, however, be certain whether they were charred accidentally as by-products of food preparation (they were generally found with maize kernels) or intentionally as fuel.

To examine how fuel-use may have changed in the thousand years covered by the samples, we first look at shifts in the general composition of the samples, i.e. in the relative proportions of mature wood, small dicot stem, and monocot stem. The proportions of the various categories are by no means assumed to reflect the proportions in which the fuel categories were actually used, given an unknown preservational bias; that is, that various types of plant remains have different chances of being preserved through charring (Smart and Hoffman 1988). However, given that the preservational properties of each plant type remains constant, and that contexts and conditions were fairly stable from site to site, we can propose that in a comparison of the assemblages from several sites or time periods, major proportional changes reflect shifts in depositional behavior (Asch and Asch 1988, Miller 1988).

Figure 6a shows the proportions of the total fragments recovered from each time period that are "wood" (mature wood), "grass" (monocot stem), and "stem" (dicot stem). The figure shows that while mature wood is the dominant category in the samples in all time periods, the proportions of stem and grass vary. The ratios (Fig. 6b) of stem and grass fragments to wood fragments show an increased relative proportion of stem and grass throughout the Pancán sequence until almost half of the remains from Pancán levels 1 and 2 are stem

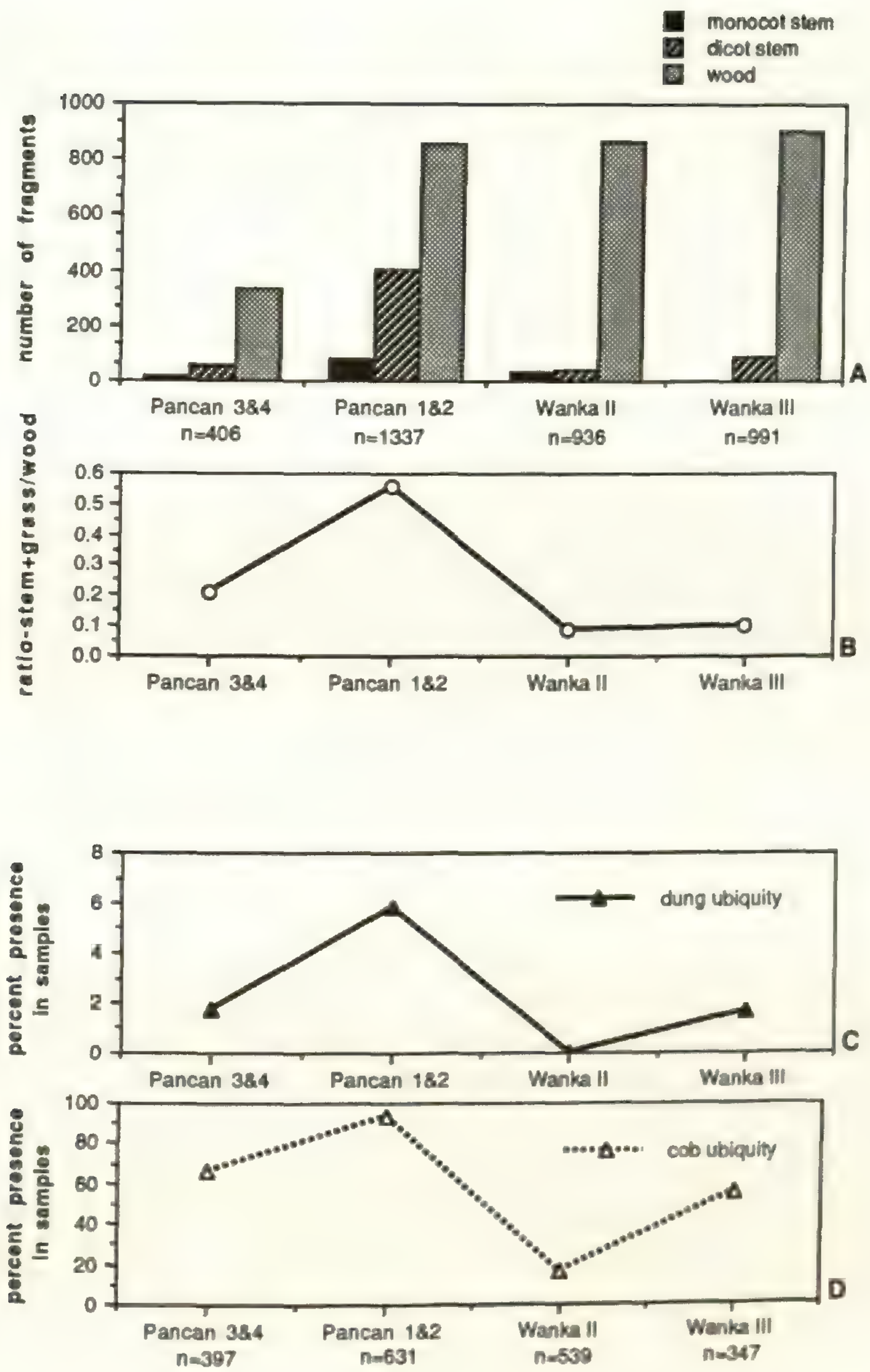

FIG. 6.—Trends in archaeological fuel categories. 6a) the relative proportions of the categories mature wood, stem, and grass (by count) and 6b) the changing ratio of stem and grass to wood (by count). The lower graphs show similar trends in the ubiquities of dung (6c) and cob fragments (6d).

and grass pieces. The trend reverses abruptly in Late Intermediate and Inca times when the samples are composed almost entirely of mature wood fragments. Figure 6c and 6d show that ubiquities (percentage presence in samples) of dung and maize cobs, other possible fuel sources, follow the trend of the relative proportion of grass and stem—rising through the Pancan sequence and dropping steeply in the Late Intermediate.

We suggest the data indicate that the people living at the Pancán site resorted increasingly to the use of twigs, stems, grasses, dung, and cobs for fuel. Several lines of evidence from the Pancán site indicate that the nature of the agricultural system was changing throughout its occupation; maize remains for example increased in ubiquity from about 30% to 95% (Lennstrom 1988), and hoes from 4% to 51% in ubiquity (Russell 1988). The increasing land clearance implied by these data may have lessened the availability of mature trees and promoted greater use of less favored fuel types. The reversal of this trend in the Late Intermediate may reflect new fuel management techniques associated with shifting patterns of land use and land tenure accompanying the major demographic and political changes apparent at about A.D. 1300 (see page 66). These new techniques apparently increased the supply of mature wood which is (at least today) a favored fuel.

Changes occur not only in the relative proportions of woody materials, but in the composition of the mature wood itself. The wood assemblages from all time periods were extremely diverse, with as many as 40 taxa represented in material from a single time period. Table 6 gives the ubiquities (percentage of

TABLE 6.—*Ubiquities of twelve major archaeological wood taxa.**

Taxon	Pancán 3&4 (n=47)	Pancán 1&2 (n=89)	Wanka II (n=117)	Wanka III (n=74)
Type U	0%	0%	0%	9%
Colletia	0%	0%	3%	18%
Cedrela	0%	0%	4%	11%
Buddleja	0%	0%	3%	27%
Type OO	17%	11%	4%	7%
Polylepis	9%	17%	7%	19%
Cassia	9%	5%	8%	12%
Type B	4%	24%	12%	12%
Type VVV	11%	8%	0%	0%
Type BBB	11%	10%	0%	0%
Type LLL	11%	23%	0%	0%
Type FFF	4%	16%	0%	0%

*Ubiquities are the percentage of the samples analyzed from that level in which the taxon was present.

samples in which a taxon was present) (Pearsall 1989, Popper 1988) of the 12 taxa most often present in samples (i.e. those with the highest ubiquities). Four of these taxa (presently unidentified) occur only in the earlier time periods, being completely absent in Wanka II and III. Four other taxa are relatively common in all time periods. Two of these are unidentified, and two have been identified as *Polylepis* sp. and *Cassia* sp. These are common Andean fuel woods and are still used in the Mantaro Valley (see Table 1). A third group of taxa occur only in the two later time periods. Three of these taxa first appear infrequently in Wanka II samples and then more commonly in Wanka III. These are *Colletia* sp., a spiny bush; *Buddleja* sp., a tree of the high elevations, and *Cedrela* sp., a tall tree typical of the *ceja* forest of the eastern Andes. Also appearing only in Wanka II and Wanka III contexts (although not among the common types listed in the table) is *Chusquea* sp., a bamboo-like monocot also typical of the *ceja* area. While most of the identified taxa are typical constituents of the high intermontane Andean vegetation, *Cedrela* and *Chusquea* grow in the warmer humid environs of the eastern Andean slopes (Weberbauer 1936, 1945), and their presence in the Mantaro indicates their importation. Importation of plant products from the eastern slopes in pre-Inca times is further evidenced by the presence of coca in Wanka II contexts (Hastorf 1987).

In sum, the fuel remains reveal both changes and continuities over a period of a thousand years. The fuel assemblages from all time periods are diverse, including many wood taxa, grass, twigs, dung and cobs. The overall composition, however, shifts as the proportion of mature wood decreases slowly through Wanka I and then increases abruptly in Wanka II (late Late Intermediate). Several of the wood taxa (some still common fuels today) are relatively common throughout the record. Others are present only in the earlier time periods, to be replaced by new taxa in the Late Intermediate and Inca periods. *Buddleja*, although a local taxon, does not appear in the record until Late Intermediate times and subsequently becomes the most common taxon in the remains from Inca period households. *Buddleja* is one of the types of planted trees mentioned in early texts. Wood of two additional taxa appearing first in the Late Intermediate were probable imports from the eastern slopes of the Andes. We believe that these data indicate that tree cultivation, forest management, and wood importation were practiced in the Mantaro Valley not only in Inca times, but in the late Late Intermediate by indigenous Wanka people at least a century before establishment of the Inca empire.

DISCUSSION AND CONCLUSIONS: CHANGE AND CONTINUITY IN FUEL-USE

In this history, created from three different types of data, we have seen significant continuities in an ancient pattern of fuel management in an environment with limited naturally-occuring fuels. The pattern since the sixteenth century includes use of a wide variety of fuels, production and management of fuel by tree-cultivation, rules governing fuel collection, use of the by-products of

domesticated animals and crops, sparing use of fuel in cooking practices, and a cultural perception of fuel as a resource as valuable as food and water.

In the Mantaro the prehispanic system under the Inca evidently could produce large surpluses of fuel, if the Wanka were able to stock the storehouses for the seventy years of Inca rule with the amounts of fuel that were there in 1533. The Wanka under Inca rule may have managed their fuel supply in part by growing trees. Archaeological data show in Inca times an increase in the occurrence of several wood taxa, especially in *Buddleja,* which documentary evidence indicates was one of the taxa cultivated by the Inca. It was also a commonly cultivated tree in the late sixteenth century, and in fact is still planted today. Archaeological evidence indicates that the pattern may have been pre-Incaic-*Buddleja* first becomes common with the increased wood use of the Late Intermediate. The Late Intermediate also yields (in the presence of *Cedrela* and *Chusquea*) the first evidence of the importation of wood from the *ceja*.

The archaeological evidence has demonstrated that the pattern of a varied fuel assemblage dates at least from the beginning of the record in A.D. 500. The first evidence of fuel management comes with the major demographic, political and social changes of the Late Intermediate in about A.D. 1300. At this time a relatively greater use of mature wood, and the appearance of one taxon that may have been cultivated and of two that were imported, implies an increased degree of fuel management.

The pattern established by late Late Intermediate times and amplified under the Inca has continued up to the present. Fuel and wood are still mostly produced; by growing trees, by using crop and herd by-products, and by importation from the *ceja*. The categories of fuel have not changed significantly since pre-Spanish times, as shown by the concurrence of the Inca period ***quipu*** categories and the distinctions made by present-day Spanish-speaking inhabitants of the valley. Fuel has long had a high value and an association with prosperity; this was explicit in 16th century documents and in the economic distinctions in fuel use today. Sparing everyday use, as opposed to lavish use in ceremony or fiesta, is another aspect of the long-term pattern also indicating the cultural value of fuel. Control over wood and fuel resources has been an important tool in the hands of those in power; first perhaps the Wanka leaders of the Late Intermediate, then seen in the Inca and later the Spanish ordinances, and presently the land-owners and cooperatives who control access to fuel.

There have been changes in the long-term pattern of fuel management, but many seem to be substitutions rather than structural changes: eucalyptus replaces indigenous cultivated trees, cow dung replaces llama dung, wheat straw replaces quinoa straw. A more basic change is being wrought by the cash economy and land privatization. The value of fuel no longer comes from the time spent gathering it, as appears to have been the case in the 16th century, but from its new place as a commodity in a cash economy. The traditional practice of tree-planting, now almost exclusively eucalyptus at the expense of the indigenous trees, serves the urban market rather than the needs of the local people. The web

of factors affecting fuel use and management has now expanded to include the international economy.

The history of fuel-use in the Mantaro has not been one in which the Wanka people have had a passive role—they have managed their landscape as well as adjusted to its changes, probably from the earliest inhabitants. Here the long-term pattern has been the tending, management, cultivation, and production of fuel resources. The Wanka people have long since actively defined their fuel resources as an integral part of their cultural ecology.

NOTES

Notes on the text. The taxonomy used follows Soukup (second edition, 1980-87). The authority is given with the first mention of the taxon. The orthography uses bold italics for Quechua words, and italics for Spanish words and the scientific names of the taxa. Translations from the Spanish sources were made by the first author with the help of Richard Omana.

[1]It is curious that no one mentions ***molle*** *(Schinus molle).* In the Vilcanota area, Gade (1975:84) lists ***molle*** after eucalyptus as the next most important fuelwood. Yet in the Mantaro Valley we have no evidence of its use presently or prehistorically, although it grows in the area today. It may be that ***molle*** is too useful and respected a tree to be used as fuel; many early writers (e.g., Cobo 1891-93, Vol. 2:84-86) comment on the respect ***molle*** received as a provider of medicines and of berries for chicha. This respect evidently continues—today ***molle*** leaves are traded into the high Andes of Bolivia for use in baking harvest celebratory bread and in weddings (Guillermo Delgado *pers. comm.*).

[2]These population estimates are based on the number of *"tributarios"* given for the three Mantaro Valley ***saya*** in Henestrosa's 1582 report. He reports 12,000 *tributarios* and says that in Inca times there were 27,000. Plausibly *tributarios* are also heads of household; an estimated five additional family members were added for each household (Rowe 1947).

[3]Municipal ordinances of Lima made in November of 1551: "2a) those who have fields are obliged to plant a thousand feet of willows and other trees within one year or be penalized by losing their fields. 3a) For making charcoal within four leagues of the city the penalty for a Spaniard will be 50 pesos, for an Indian the loss of the charcoal and ten days in jail, for a slave 30 pesos or 100 azotes, whatever his master desires; and for a second offense 100 azotes and the loss of the charcoal; and the same penalty applies to girdling trees. 4a) If anyone cuts a fruit tree, except on their own property, the penalty will be 30 pesos to a Spaniard and 100 azotes to an Indian or Negro. 5a) If anyone burns large logs *(leña gruesa)* in ovens, the penalty will be 12 pesos if bread is being made, and 50 if lime or bricks are being made" (Jiménez de la Espada 1965:123).

[4]The University of Minnesota Archaeobotanical Laboratory reference collection was compiled by Dr. Christine A. Hastorf in the years 1977 to 1985. Vouchers were identified by Dra. Emma Cerrate of the Museo de Xavier Prado, Lima. The collection includes wood specimens from 60 taxa of common Andean woody plants. The wood of an additional

28 Andean taxa was examined at the Forest Products Laboratory in Madison, Wisconsin, with the kind assistance of Dr. Regis Miller.

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APPENDIX 1. Questionnaire used in fuel-use interviews.

1) *Que quema en su fogón? y que tipo?* (What do you burn in your hearth? And what type?)
leña? guano? paja? mazorcas? otro?
(firewood? dung? straw? cobs? other?)

2) *Qual usa con la mas frecuencia?* (RANK FREQUENCY) (Which do you use most frequently?

3) *Donde va para recoger éstas cosas?* (Where do you go to collect these things?)

4) *Cuantas veces va para recoger éstas cosas?* (How often do you go to collect these things?)
diariamente? cada semana? cada estación?
(daily? each week? each season?)

5) *De las cosas que usa en el fogón, cuales son las mas preferidas?* (RANK PREFERENCE) (Of those things you use in the hearth, which are most preferred?)

6) *Cuántas veces incendia el fogón cada día?* (How often do you light the hearth every day?)

7) *Vacía el fogón?* (Do you empty the hearth?)

8) *Dónde se bota el contenido del fogón?* (Where do you throw the contents of the hearth?)

9) *Se usa la ceniza del fogón para algo mas? Sirve para algo?* (Are the ashes from the hearth used for anything?)

BOOK REVIEW

Plants of Dhofar; The Southern Region of Oman: Traditional, Economic and Medicinal Uses. Anthony G. Miller and Miranda Morris. Muscat, Sultanate of Oman: The Office of the Adviser for Conservation of the Environment, Diwan of Royal Court Sultanate of Oman (P.O. Box 246), 1988. Pp. xxvii, 361, plates, endpaper maps, appendices, bibliography, index. £35.00.

In the Preface to this important work, Professor Richard Evans Schultes outlines three aspects of conservation "most urgently in need of wide and constructive attention: one, the protection of plant species in danger of extinction; two, the salvaging of the knowledge about plants and their properties which is in the hands of fast disappearing cultures; and three, the domestication of new crop plants or, in broader terms, the conservation of germ plasm of economically promising species" (p. ix). Since the second—the salvaging of disappearing folk knowledge of plants—often provides invaluable ammunition in the fights for protection and development of promising plants, it is especially important that books such as the one under review be published and widely disseminated.

Fortunately, His Majesty Sultan Qaboos Bin Said, Sultan of Oman, shares these views. Citing (p. vi) "a great store of knowledge about medicinal and economic uses for a wide range of our wild plants" still held by the people of Oman, he has long sponsored efforts "to record as much as possible of this useful knowledge and to preserve the plants upon which it is based, before either or both disappear," and "to direct the development of our natural resources towards their rational use for raising the quality of life and education of our people."

Anthony G. Miller, of the Royal Botanic Garden at Edinburgh, provides a botanical introduction (pp. xi-xvii), describing the geology, topography, climate, vegetation zones, and phytogeography of Oman. While systematic plant collecting began there in 1894, extensive surveys were conducted in the late 1970s, and the present work is largely the result of those.

Miranda Morris, trained in Arabic Studies at the School of Oriental and African Studies (London), contributes a specialist introduction (pp. xviii-xxv). On the basis of her long-term research in the languages and ethnography of Oman, she selected the plants to be included on the basis of their nutritional or medicinal significance, their importance as fodder, and some on more general grounds. Her discussion of Jibbali and Dhofari plant names (also listed in an appendix) will interest ethnosystematists given the apparently low frequency of binomials. General discussions of agriculture, leatherworking, and traditional medicine serve as a useful context for the more specific information given for each plant.

The heart of the book, of course, is a presentation of the plants themselves (pp. 1–334). Nearly 150 species (out of a total of over 750 spp. in Dhofar, and 1,100 in Oman as a whole), mainly from the annual monsoon rainfall zone, are included in a standardized format: alphabetically by family, a page of text faces a full-page color plate (seemingly based on watercolor paintings and sketches, superbly executed by Susanna Stuart-Smith). Somewhat inconveniently, in many instances the text runs to more than a page and, to retain the format, is resumed much later in the book (e.g., pp. 20 and 296). Varying detail is provided for the plants but for each a technical botanical description is given along with a more narrative description, including its names, uses, and (sometimes) references to uses elsewhere in the world. The plates—some of which are the first illustrations ever to be published of particular species—are not glossy, but the paintings (most of which were done from living material) are clear. Many are lifesize, and usually the whole plant is depicted as well as flowering parts, fruits, seeds, etc.

Appended material (pp. 335–361) includes a checklist of plants, Jibbali and Dhofari plant names, a glossary of botanical terms, a glossary of specialist terms, a select bibliography, and an index.

While it would have been useful to include photographs of at least some of the plants in their use contexts, the work as a whole is magnificent and an invaluable contribution towards the goals articulated by Schultes and the project's royal sponsor. The urgency of such endeavors is underscored by the fact that "(the) past tense is usually used throughout the text, partly for the sake of consistency, but partly also because this reflects present-day realities" (p. xxvi) in Oman, where expertise still exists, but its deployment is rapidly giving way in the face of modern developments. We all stand warned.

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INTELLECTUAL PROPERTY RIGHTS: WHAT IS THE POSITION OF ETHNOBIOLOGY?

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During the First International Congress of Ethnobiology held in Belem, Para (Brazil), July 19–22, 1988, scientists and native peoples from 35 countries met to discuss the importance of traditional knowledge and its application to the development of socially equitable and ecologically sustainable options for the Planet. Although the examples of indigenous knowledge systems, ecological variations in different regions of the world, and suggestions for applications of native concepts varied greatly, common themes appeared and reappeared throughout the Congress. The richness and relevance of traditional knowledge was evident in all cases, as was the global threat of extinction to native peoples and their cultures.

Industry and business discovered many years ago that indigenous knowledge sometimes means money. In the earliest forms of colonialism, extractive products were often the basis for colonial wealth. More recently, pharmaceutical industries have become the major exploiters of traditional medicinal knowledge for major products and profits.

The annual world market value for medicines derived from medicinal plants discovered from indigenous peoples is US $43 billion. Estimated sales for 1989 from three major natural products in the US alone was: Digitalis (although not from an "indigenous" culture), US $85 million; Resperine, US $42 million; Pilocarpine, US $28 million. (Source: Fundacão Brasileira de Plantas Medicinais—FBPM.)

Although no comparable figures are published for natural insecticides, insect repellents, and plant genetic materials acquired from native peoples, the annual potential for such products is easily that of medicinal plants. Research into these natural products is only beginning, with projections of their market values exceeding all other food and medicinal products combined. The international seed industry alone accounts for over US $15 billion per year, much of which derived original genetic materials from crop varieties "selected, nurtured, improved and developed by innovative Third World farmers for hundreds, even thousands of years" (*South*, September 1985:95).

Likewise, natural fragrances, dyes, body and hair products are coming to account for major world markets. Figures from the Body Shop, considered to be one of the new stars of success in international enterprise, show an annual sales of $90 million with a growth rate last year of 60% (*Time*, April 23, 1990:39). The 300 Body Shop products are derived from plants, are not tested on animals, and mostly come from ''Third World'' countries. These products are marketed as coming from ecologically sustainable projects managed by the native peoples themselves. The success of Anita Roddick, founder of the 14-year old British company, has earned her the title of Britain's ''Retailer of the Year.'' Such renown will not go unnoticed by the hundreds of would-be clones that will appear to take up Anita's marketing strategy.

Growing interest and catapulting markets in ''natural'' food, medicinal, agricultural, and body products signals increased research activities into traditional knowledge systems. Now, more than ever, the Intellectual Property Rights of native peoples must be protected and just compensation for knowledge guaranteed. We cannot simply rely upon the ''good will'' of companies and institutions to ''do right by'' indigenous peoples. If something is not done now, mining of the riches of indigenous knowledge will become the latest—and ultimate—neo-colonial form of exploitation of native peoples.

THE BASIC CONDITIONS FOR SURVIVAL

Basic conditions for survival of native peoples are spelled out in the United Nations International Labor Organization Convention 107, which was adopted in 1957. Major changes were recommended in 1987 in an effort to remove the ''integrationist'' language of the original Convention that is seen as contrary to native cultural sovereignty. An amended Convention, known as ILO 169, was improved in 1989 and is the only international instrument in existence that deals exclusively with indigenous rights. There are, however, many other declarations, international agreements, laws, and manifests that express concerns of and for native peoples.

Most conventions and declarations agree that the first condition for survival of native peoples is LAND. For this reason, right to land is viewed as a basic human right of all native peoples. Other essential conditions include: equal opportunities under the law, access to vocational and educational institutions, adequate social security and health assistance, right to decide which group(s) and individual(s) are to be considered ''indigenous,'' and respect of native language laws, and customs.

There are no provisions anywhere for the protection of knowledge rights of native peoples. Despite repeated pleas from indigenous leaders that their traditional culture and knowledge systems are being exploited without just compensation, little action has been taken by legal, professional, environmental, non-governmental, governmental—or even human rights—groups to secure Intellectual Property Rights (IPR) for native peoples.

The World Intellectual Property Organization (WIPO) and UNESCO have both tried to work within the United Nations system to develop model conventions

to protect folklore and "artistic" aspects of indigenous knowledge. Nothing has gone beyond proposals, however, and currently there is no push to deal with IPR in any existing or future UN Conventions.

In July, 1988, representatives of native societies, scientists, environmentalists, and journalists from 35 countries met to discuss the relevance of indigenous knowledge to the future of the planet. This First International Congress of Ethnobiology produced a historic document called the "Declaration of Belem," which is the first international document specifically calling for the just compensation of native peoples for their knowledge and the legal defense of indigenous Intellectual Property Rights.

There is considerable opposition to IPR for native peoples—even ethnobiologists and anthropologists—who fear that they will have to drastically change their "lifestyles." Incomes from published dissertations and other books, slides, magazine articles, phonograph records, films and videos—all will have to include a percentage of the profits to the native "subjects." It will probably become normal that such "rights" be negotiated with native peoples prior to the undertaking of initial fieldwork. This kind of behavior has never been considered as part of the "professional ethic" of scientific research, but certainly will become so in the near future.

The strongest opposition to IPR comes—as no great surprise—from the companies that have been the major predators upon traditional knowledge in the past: the pharmaceutical industry and seed companies (now subsumed by the "biotechnology" label). Both groups would have to make major changes in the ways they do business—and paying for the basic information and genetic materials necessary to generate their profits would heavily pinch their profit margins.

AN INDIGENOUS VIEW

Indigenous leaders lament the difficulties of their younger generations to see options for economic security without following the ecologically destructive ways of the "Industrialized World." How can traditional knowledge be defended and valued within a native society when, in fact, such knowledge offers little economic benefit to indigenous groups caught in the economic maze of consumerism and basic survival?

Kayapo chief, Paiakan, told in the opening ceremonies of the First International Congress of Ethnobiology how warriors from his people travelled to the Brazilian capital during the Constitution Convention in order to defend native peoples against proposals that, if included in the new constitution, would have stripped many groups of their protective status as Indians. Had the physical presence of the Kayapo lobby not been evident during the Convention, he explained, Indians would not have achieved the new laws that guarantee to them in the new Constitution the right to independent legal representation and decisions regarding their lands would still be signed "behind closed doors" by government officials.

Ironically, with all of the much-heralded biological and ecological richness of Amazonia, the only products that command stable and reasonable prices are

cattle, minerals, and timber—all of which require the destruction of tropical ecosystems in order to be attained. This pattern is repeated time and time again throughout the world.

The Kayapo were in a fortunate position: they are relatively wealthy Indians, whose money comes from mining and lumber extraction.
It was with gold and timber money that the Kayapo sent on many occasions their 100+ warrior delegations on the costly 1,000 kilometer trip to the Capital, Brasilia. ''If we had not had that money,'' explained Chief Paiakan, ''Brazilian Indians would have had to sit helplessly on their reserves as the politicians did exactly what they wanted. The government certainly was not interested in funding our journeys to the Capitol. Indians these days must have financial resources too. Our people want radios and batteries for their tape recorders. We need the ''White Man's'' clothes when we go to the city—and we must go to the city to defend ourselves against those who would dispossess us of our lands and turn us all into 4th class citizens with no food, medicine, or money.''

Native peoples must have economic sources—and, if such income is to preserve the land, the people and their cultures, then traditional knowledge itself must be compensated in financial terms. Otherwise, native peoples themselves must revert to ecological destruction, associated with atrophy of their own knowledge systems, in order to acquire the economic power they need to survive.

FEARS OF TOO MUCH SUCCESS

Ecologists are justifiably concerned with the ecological impact of production of ''natural products'' that become too successful. The tendency is always toward monocultures of cash crops. Many worry that international demands may spell the end of biodiversity, rather than encourage conservation of natural resources as intially desired.

Michael Soule and Kathryn Kohm outline this concern in their recently published book, *Research Priorities for Conservation Biology*:

> ''Increased pressure on biological resources arises because of increasing human populations, changing consumption patterns, and new technologies. Although agricultural intensification will continue to be necessary, its impact on biological resources is not predetermined. Conservation poses important research questions relevant to the design of new production technologies and land use systems: Can biologically diverse and low energy technologies be extended and/or intensified? Can production systems be differentially intensified so as to maintain biological diversity in other parts of a system? How does increased exploitation of specific species affect other species and general system properties?''

Provocations of cultural changes can be equally disconcerting. By establishing mechanisms for ''just compensation'' of native peoples, are we not also establishing mechanisms for the destruction of their societies through the subversion of materialism and consumerism?

Given current realities, such concerns are reduced to romantic notions. The fact is that indigenous societies and their natural environments are being destroyed by the dramatic expansion of industrialized society NOW. And, besides, pharmaceutical companies and "natural products" companies have tasted success in their efforts: they will not go away.

Certainly the mechanisms of WHAT is "just compensation" and HOW such benefits would be distributed opens a "Pandora's Box." But to NOT open this Box is to accept the ethical and moral responsibility of "paternalism" (those from "advanced societies" know what is good for the "native" because "we" have already made the mistakes of squandering our cultural and natural wealth) that has undermined indigenous independence since the first wave of colonialism.

Native peoples must have the right to choose their own futures. Without economic independence, such a choice is not possible. The current devastation of native peoples and the ecological systems that they have conserved, managed, and intimately known for millennia, require that new and drastic steps be taken to reorient world priorities. All channels and organizations—governmental, non-governmental, professional, business—must work together to reverse the current momentum in loss of cultural, ecological and biological diversity of this planet.

Three major accomplishments must occur:

(1) giving economic value to the LIVING forest and natural habitats through the valorization of "natural products"; (2) recognition that native peoples hold the key to understanding the rational use and management of these living natural areas; and (3) developing legal and practical mechanisms for the "just compensation" of native peoples for their knowledge through the guarantees of Intellectual Property Rights for traditional knowledge.

I want to make it very clear that I DO NOT advocate the *imposition* of consumer capitalism and ties to market economices upon native peoples. Each group must have the option to enter into market economies or not—and to what extent and under which circumstances they want to do so—or not do so. I only wish to point out that pressures to exploit traditional knowledge are drastically increasing, and that native peoples ought to at least have the option of just compensation for their knowledge.

To secure Intellectual Property Rights and just compensation for traditional knowledge is critical to the survival of ethnobiology and anthropology, since indigenous peoples are increasingly leery of researchers and protective of their knowledge. At the same time, if "Green Consumerism" is to function to divert the all out destruction of remaining Planetary natural resources and native peoples, then preservation of the LIVING forests and LIVING peoples is essential. Ecologists tell us that that is the only way we can save the planet. This can be done only with secure protection of indigenous lands and economic independence for native peoples.

These complex issues will be discussed in several symposia of the Second International Congress of Ethnobiology in Kumning, China, 21–25 October, 1990.

This Congress will be the next step toward the development of a position of ethnobiologists toward IPR and the "just compensation" of native peoples for their knowledge. I hope that both the Society of Ethnobiology and the International Society of Ethnobiology will take the intellectual lead—as well as appropriate actions—toward the development of a new ethic that serves as a model for other disciplines.

I suggest the following action be taken:

(1) Support an international call, through its members in all countries that participate in United Nations activities, for UN action on the question of IPR;

(2) Seek national legislation to secure indigenous IPR rights in all countries where native populations exist;

(3) Encourage funding agencies and development banks to support research into traditional knowledge, its practical applications, and ways that native peoples can be "justly compensated" for their knowledge;

(4) Establish a special Working Committee to investigate the issues of IPR in relation to native rights and report to the Society with guidelines for international and national legislation;

(5) Include on the agenda of an Ethics Committee the issues of IPR in relation to activities of researchers with indigenous populations.

EDITOR'S NOTE: It is important to point out that Posey's article on Intellectual Property Rights (IPR) is a position/opinion paper. It was completed on May 10, 1990 and arrived in my office approximately two weeks later. Although the present issue was about ready to go to press, I thought it important that this paper be published in Volume 10, No. 1 because date of issue of Volume 10, No. 2 will be after the meeting of the Second International Congress of Ethnobiology, at which time IPR "will be discussed in several symposia." IPR is a complex, multi-faceted issue. It is important that all aspects be intelligently and compassionately considered and assessed before this or any other society or organization makes any firm decisions or rulings about it. In this connection, then, I encourage members of the Society of Ethnobiology and readers of the *Journal* to contact Dr. Darrell Addison Posey as soon as possible and preferably no later than October 1, 1990, so that he will be aware of the many viewpoints on the many different aspects of IPR.

I wish to make it known that I did not send this paper out for peer review because of lack of time. I felt it was important that the readers of this journal be made aware of the complexities of IPR and be invited to make their opinions and facts at their disposal known so they can be taken into account during the discussions of IPR in China, 21–25 October, 1990. I recognize that many readers of the *Journal* will agree in whole or in part with this paper. At the same time other readers will object vehemently to it, again, either in whole or in part. Had there been time for the paper to have been peer-reviewed, it is likely that reviewers would have suggested revisions, given additional or what they might consider better sources of information; it's possible that one of the reviewers might have recommended that the paper not be published. I decided to publish this paper, which Posey himself recognizes is just a summary, so that any additional references, facts, figures, and viewpoints can be made available to the participants in the symposia at the Second International Congress of Ethnobiology. Please send/telephone/Fax any such information to Dr. Posey. I also suggest that you send a copy to the *Journal's* News and Comments Editor (see the inside front cover for his address).

Dr. Posey can be contacted by mail at his West Germany address or by telephone at (49) (89) 810-7108 or via FAX at (49) (89) 810-7300.

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SHORT COMMUNICATIONS

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'uxa Identified.

Among the scattered brittle and often well-armed vegetation of Mexico's central desert in the state of San Luis Potosi, bands of Huichol Indians return each year during the dry season to stalk, hunt and collect the hallucinogenic peyote cactus ***(hicuri)*** *(Lophophora williamsii* Lemaire & Coulter). Another plant "hunted" on this archaic religious pilgrimage is a nondescript grayish shrub whose roots are harvested and treasured as the raw material for preparing a sacred yellow face paint still used today as it was nearly 100 years ago (Carl Lumholtz, 1900, *Symbolism of the Huichol Indians,* American Museum of Natural History, Memoirs 1(2), New York, p. 25, 34-35, 196); (1973 [1902], *Unknown Mexico,* Rio Grande Press, Glorieta, New Mexico, p. 141-143). Despite additional published references to the plant in the intervening years, only now for the first time is a scientific name provided for this notable and holy shrub.

Lumholtz referred to the plant as ***toy*** (1900:25, 35). ***Toy*** has recently been identified as a species of *Karwinskia* ***(tui*** or ***tuuvii)*** *(Bauml & Voss 1768)* with small, edible black fruits and with foliage used medicinally and for spiritual cleansing (Benitez, 1975, *In the Magic Land of Peyote,* University of Texas Press, Austin). It does not appear to be the source of a yellow pigment.

Robert Mowry Zingg (1938, *The Huichols: Primitive Artists,* G.E. Stechert, New York) noted the use of this yellow face paint and used the name ***kieli*** for the plant (1938:584-585). That name is used today for an unidentified *Solandra* species *(Bauml & Voss 2101)* which is a sacred plant but not the source of a yellow paint. More recently, Barbara Meyerhoff (1974, *Peyote Hunt,* Cornell University Press, Ithaca, New York) witnessed the peyote trip and described ***'uxa*** as a "desert laurel" collected from a location near a lake known as Agua Perdida (p. 147n). Ramon Mata Torres (1980, *El Arte de los Huicholes,* Guadalajara) describes a search for the roots growing in the walls of an arroyo and provides a photograph of the root (p. 80, 84). Benitez (1975) narrates the discovery and use of ***'uxa*** in Huichol myth (p. xxi, 135) and song (p. 76-77) and identifies the place where the

plant grows as ***'Uxataremekamakuu,*** 'the place where the gods painted themselves yellow' (p. 135).

Face painting designs have been figured or interpreted by Lumholtz (1900: 11, 35, 196-203; 1973:141-142), Zingg (1938:584, 585), and Mata Torres (1980:82-83). Photographs illustrating this tradition have been published in the last dozen years (Norman, 1977, Mexico's People of Myth and Magic, *National Geographic* 151(6):836; Berrin (ed), 1978, *Art of the Huichol Indians,* p. 21, 45, 136).

The authors found that the plant as well as the roots are called by the Huichols ***'uxa*** or ***'uxa mutaaxauye.*** According to linguist Joseph Grimes (1989:*pers. comm.)* ***'uxa*** is a marking, including one made with paint. ***taaxaa-*** refers to the dry season, and ***-taaxauye*** refers to ''anything that is dry season color, basically the color of dried grasses but extending into the vivid yellows of pigments.'' The seasonal reference may relate to the dry-season peyote pilgrimage and related ceremonies with which the paint is associated. The phrase ***'uxa mutaaxauye*** can refer equally to the substance put on the face or to the resulting design. Lumholtz (1900) used the names ***'ura*** and ***uram tarai,*** for the face paintings, and he translates the names 'spark' and 'yellow root spark' respectively (p. 196). Lumholtz also referred to the root as ***tarai*** (p. 25), possibly a corruption of ***-taxauye*** (see above) or of ***tauxi*** which, according to Grimes (1989, *pers. comm.)* is a generic term for face paints.

The 'spark' translations above correspond better with Lumholtz' association of peyote with the gods of fire, Grandfather Fire and Great-Grandfather Deer-Tail whose colors are yellow (p. 34, 196). He explains that sparks from the now archaic flint and steel are the facial painting of the two gods (p. 10-11). He later states that the designs may actually represent the faces of several or all of the gods (p. 196). In contrast, Zingg recounts an association of the yellow paint with the ''multicolored foam from the mouth of the first deer, Peyote,'' which sprang up when it was killed (1938:585).

As a participant in the peyote pilgrimage on several occasions, the third author observed the collection of this root. After the party approached the plants, smoke from sacred tobacco was blown at them and some questions asked of them. Roots sections up to 15 cm long and 1-2 cm in diameter lying close below the surface were then dug out and the bark scraped away with a knife. Older plants are selected because they are believed to produce a superior quality of yellow pigment.

Rock samples ***(tapaari)*** used for grinding the roots are also collected in the peyote desert in a location named ***Tapaarimatimani.*** These rocks are naturally flat, a rusty brown color, and approximately rectangular in shape. One such stone measuring 7.7-9 cm wide by 10-10.2 cm long was characterized as finely crystalline olivine norite.

To prepare the paint, one end of the root is alternately wetted with water and rubbed against the stone in the direction of the tip to release the pigment. The resulting paint is collected on the end of a finger with a piece of straw (Meyerhoff 1974:173; Lumholtz 1900:196; 1973:142) or a with a toothpick-sized stick, and it is painstakingly applied with the help of a small mirror. After the period of use, the dried paint is washed off (Lumholtz, 1973:143) or carefully removed, collected, and burned as an offering.

Voucher specimens *(Collings s.n.)* have provided a means of identifying the source plant as *Mahonia trifoliolata* (Moric.) Fedde var. *glauca* I.M. Johnson (= *Berberis trifoliata* Hartw. ex Lindl.) of the Barberry family (Berberidaceae), a 1-2 meter tall shrub which ranges from Texas, westward to southern Arizona, and southward into north-central Mexico (Ahrendt, 1961, *Berberis* and *Mahonia*. A taxonomic revision, *Journal of the Linnean Society of London* 57(369):352-353). Uphof (1968, *Dictionary of Economic Plants,* 2nd ed., Von Cramer, Lehre, Germany), mentions eleven taxa of *Berberis* (not including *B. trifoliolata),* of which seven are used to produce a yellow dye. According to Standley (1922, Trees and Shrubs of Mexico, *Contributions from the United States National Herbarium* 23(2):271), this plant (treated as *Odostemon trifoliolatus),* has wood which is the source of a yellow dye. He notes that in Mexico it is known as "agritos," "agrillo," and "palo amarillo." In Texas and New Mexico, the name "agrito" has been corrupted into "agarita" and even "algerita."

ACKNOWLEDGEMENTS

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Herbarium voucher specimens are deposited at the herbaria of the Rancho Santa Ana Botanic Garden, Claremont, CA (RSA) and at the Universidad Autonoma de Mexico, Mexico City (MEXU).

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NEWS AND COMMENTS

LIFE MEMBERSHIPS

Life memberships in the Society of Ethnobiology are now being offered. Simply contribute $1000, $250 per year for five years, or $200 per year for six years. Your contributions will help the Society achieve fiscal solidity.

SOCIETY NEWSLETTER PROPOSED

A consensus is developing that a newsletter should be published by the Society to incorporate "News and Comments" as well as discussions of timely issues of interest to the members. It is hoped that such a newsletter could begin publication as early as the fall of 1990. The Society for Economic Botany's newsletter provides one model. Newsletters have the advantage of timeliness and informality, thus complementing the *Journal*.

But, the catch is that we need a volunteer to take on the role of newsletter editor, as I am unable to do so. The editor should have access to a desktop publishing micro-computer setup. Interested persons should contact Willard Van Asdall, Editor, *Journal of Ethnobiology,* Arizona State Museum, Building 26, University of Arizona, Tucson, AZ 85721 A.S.A.P. Suggestions for a catchy newsletter title and/or logo are also welcome.

APPLIED ETHNOBIOLOGY PROJECTS

Reports and evaluations of any applied ethnobiological research efforts are eagerly solicited for inclusion in a special section of the newly proposed Society newsletter. Please forward any and all such contributions to Dr. Janis Alcorn, 4813 Morgan Dr., Chevy Chase, MD 20815.

INTELLECTUAL PROPERTY RIGHTS ISSUE

The question of the rights of indigenous peoples to a fair share of the financial benefits realized from marketing products derivative of their ethnoscientific knowledge will be discussed at the forthcoming Second International Congress of Ethnobiology scheduled for October 1990 in Kunming, Yunnan, China. Dr. Janis Alcorn raised the question of the Society's stand on this issue at the editorial board meeting last March in Phoenix. If you would like to express an opinion or discuss specific cases relevant to this key ethical issue, please forward your comments to Dr. Alcorn for inclusion in a forthcoming issue of the newsletter.

TIMOTHY C. PLOWMAN FUND FOR SOUTH AMERICAN RESEARCH

This fund has been established at the Field Museum of Natural History in Dr. Plowman's memory to support travel and research by students pursuing careers in tropical botany or ethnobotany, both in the United States and in Latin America. Please send your contributions to Michael O. Dillon, Associate Curator, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605-2496 (312-922-9410).

FORTHCOMING CONFERENCES

SECOND INTERNATIONAL CONGRESS OF ETHNOBIOLOGY
Kunming, Yunnan, China — October 21–26, 1990

Prof. Dr. Pei Shenghi is chair of the organizing committee. Deadline for receipt of registrations and abstracts is July 15, 1990, addressed to Prof. Dr. Pei Shengji, Head, Ethnobotany Department, Kunming Institute of Botany, KUNMING, Yunnan, China 650204.

FOURTEENTH ANNUAL CONFERENCE OF THE SOCIETY OF ETHNOBIOLOGY
St. Louis, Missouri, USA — March 13–16, 1991

Contact Prof. Patty Jo Watson, Department of Anthropology, Washington University, Campus Box 1114, One Brookings Drive, St. Louis, MO 63130-4899 (314-889-5252 or 314-862-7646) for more information. The conference will be co-hosted by Washington University and the Missouri Botanical Garden. Field trips are being planned to the local arboretum and zoo, the botanical garden, and the Cahokia mounds.

CONFERENCES PAST

CORN AND CULTURE IN THE PREHISTORIC NEW WORLD, a conference held at the University of Minnesota, May 11–13, 1990, was organized by Dr. Christine A. Hastorf and Sissel Johannessen, Department of Anthropology, University of Minnesota (612-625-3400). Three plenary sessions covered "Methods of analysis of maize from archaeological contexts," "Temporal and spatial variation in corn and culture," and "Culture meanings."

VISIT

Dr. S.K. Jain, Emeritus Scientist (CSIR) and ex-director of the Botanical Survey of India, now chair of the Commission on Ethnobotany (CEB) of the International Union of Anthropological and Ethnological Sciences (IUAES) and editor and publisher of the CEB Newsletter, will visit the United States in September and early October 1990. If you could arrange financing for a visit by Dr. Jain to your area contact him c/o Mr. Sunil Kumar, 10554 Coppergate, CARMEL, Indiana 46032 (317-844-9430).

Dr. Jain also announces the first issue in March 1990 of a new journal, *Ethnobotany,* for which he serves as chief editor. Address inquiries to him at the National Botanical Research Institue, Lucknow, U.P., India 226 001.

ITEMS IN THE NEWS

French Revolution blamed on ergot infected rye bread. Mary Kilbourne Matossian, Associate Professor of History, University of Maryland, argues in her new book, *Poisons of the Past: Molds, Epidemics and History* (Yale University Press), that the "Great Fear" which precipitated the revolution in 1789 was due to the hallucinogenic effects of ergot alkaloids. Other historians dispute this.

—AP to the *Seattle Post-Intelligencer*
November 21, 1989

Filipino legal group fights environmental destruction. Attorneys representing *Tanggol Kalikassan,* literally "In Defense of Nature," spoke at the University of Washington, Seattle, April 12, 1990 at the start of a tour of the United States. The legal group was founded in 1988 with assistance from the Haribon Foundation, a Philippine environmental protection organization. A major current effort of the organization is to gain recognition for a Communal Forestries Agreement to control logging on tribal lands.

—*The Daily of the University of Washington*
April 19, 1990

First equestrians dated to 4000 BC. David Anthony, Hartwick College, Oneonta, New York, reports that scanning electroni microscopic analysis of horse teeth from near Dereivka, Ukraine, U.S.S.R., dated to ca. 4000 BC show scratch patterns like those caused by metal bits used on modern horses. Such marks are not found on modern wild horses. This find antedates the first known wheeled vehicles by 500 to 700 years, according to Dr. Anthony.

—UPI to the *Seattle Post-Intelligencer*
May 25, 1990

Richard Evans Schultes and Robert F. Raffauf's book *The Healing Forest: Medicinal and Toxic Plants of the Northwest Amazon* with a preface by H.R.H. Prince Philip, Duke of Edinburgh (Dioscorides Press, Portland, Oregon) appeared in May. It considers the botany, ethnopharmacology and, when available, the chemistry of some 1500 species.

Richard Evans Schultes was recently elected a fellow of the National Academy of Sciences of India and of the Third World Academy of Sciences.

ANNOUNCEMENT

The *Journal of Ethnobiology* is now accepting manuscripts in Spanish.

Effective immediately, the *Journal* will accept manuscripts in Spanish. All manuscripts in Spanish should be submitted to Associate Editor Alejandro de Avila B. who will supervise their review, and, if accepted for publication, will edit them (see inside front cover for his address).

The concensus of the Board was that if the publication of abstracts in Spanish and French and of articles in Spanish works out well, it will next consider the publication of full length articles in other languages in an effort to broaden the international scope of the *Journal*.

ANUNCIO

La publicación *Journal of Ethnobiology* está aceptando manuscritos en español.

De forma inmediata, el *Journal* está aceptando manuscritos en español. Dichos manuscritos deberán ser embiados a Alejandro de Avila B., Associate Editor, quien se encargará de supervisar el proceso de revisión, y tambien adaptará aquellos que se acepten para publicación (vea la contraportada del libro para el domicilio).

El consejo de administración llegó al consenso de que si son bien recibidas las publicaciones de resumenes en español y francés, y artículos en español, considerará publicar artículos completos en otros idiomas con el objecto de promover el *Journal* a un nivel internacional más extenso.

ABRIDGED MINUTES OF THE EDITORIAL BOARD MEETING OF THE SOCIETY OF ETHNOBIOLOGY TEMPE, ARIZONA 21 MARCH 1990

GENERAL BUSINESS

Those attending: Willard Van Asdall (presiding), Karen Adams, Janis Alcorn, Alejandro de Avila B., Eugene Hunn, Paul Minnis, Amadeo Rea, Mollie Toll, Nancy Turner, Elizabeth Wing.

The Society has two new book review editors, Nancy Turner of Canada and Carlos Coimbra, Jr. of Brazil. Alejandro de Avila B. of Mexico was appointed as an associate editor in 1988. It was proposed and accepted that the Society make $100.00 available yearly to each editor or book review editor outside of the U.S.A. to help defray their postage expenses. Because of these new additions to the editorial staff, Willard has developed new *Journal* stationery with names, addresses and telephone numbers of all editors. In addition to general correspondence, book review editors can use this letterhead to write publishers to request review copies of new books on topics of interest to our members. It was suggested that the stationery be printed on recycled paper.

The questions of developing a special section in the *Journal* to report on applied ethnobiological efforts was discussed. Janis Alcorn volunteered to ask for submissions of short reports to see if responses are adequate to start a new section. The next News and Comments column will request these submissions.

The financial status of the Society was reported by Liz Wing and the proposed new rate schedule was presented to the Board. Papers for the issue in honor of the late C. Earle Smith (Vol. 10, No. 2) are still being accepted. The original deadline of December 1, 1989 has been relaxed, due to some confusion. Donations and contributions are still requested to help pay for publication of this issue.

NEW POLICIES FOR LITERATURE CITED SECTION OF MANUSCRIPTS

The use of abbreviations in the Literature Cited sections of manuscripts submitted to the *Journal* was discussed. The Board felt that readers from non-English speaking countries, whom we are trying to encourage, might have difficulty in accessing the primary literature when the journal titles and publishers are abbreviated. Any space-saving advantage of this practice is outweighed by the resulting increased clarity provided by fully written out citations. Authors are to be cited as they appear in the original publication, i.e., with full names or initials, depending upon how the names appeared in the papers cited. The motion was made, seconded, and carried by a voice vote that beginning with Vol. 10, No. 2, the issue in honor of the late C. Earle Smith, these new policies will be instituted.

INTERNATIONAL PARTICIPATION AND LANGUAGES

Attempts to encourage international participation in the *Journal* have been partly successful. Alejandro has heard from a number of authors about potential Spanish language submissions. It was proposed that the *Journal* publish in Spanish the announcement (already published in English) that Spanish language papers are being actively solicited by Associate Editor Alejandro de Avila B. He also encourages Spanish speaking authors to submit in Spanish short research reports and general newsworthy items for publication.

A series of Spanish language abstracts previously published in Vol. 9, No. 1 have been much improved by Alejandro. These new versions will be published in Vol. 10, No. 2. Alejandro proposed that Brazilian authors provide abstracts in Portuguese rather than in Spanish. This proposal was accepted by the Board.

GUIDELINES

The "Guidelines for Authors" will need to be revised to accomodate recent changes. The new "Guidelines" will encourage authors to not only give the authors of the scientific names of plants and animals reported in their manuscripts but to also report *where* their voucher specimens have been submitted for curation. Researchers will be referred to three articles in the 1986 Special Issue (Vol. 6, No. 1) where voucher specimens and scientific procedures are clearly discussed by Robert Bye, Amadeo Rea, and Harriet Kuhnlein.

ADVERTISEMENTS IN THE JOURNAL

Paul Minnis presented an outline of logistics and concerns regarding the acceptance of advertising copy into the *Journal*. The Board of Trustees and the Editorial Board decided that our tenuous financial status, including the need to repay a start-up loan, requires that we solicit advertising. Paul will chair a committee, along with Liz Wing and Will Van Asdall, to spearhead the *Journal's* debut into the advertising realm. Paul will supervise a mass mailing to appropriate advertisers of books, workshops, etc. Actual decisions on advertising requests will be made by the Editor with two others asked for input.

ISSUES

The question of Intellectual Property Rights (IPR) is currently an international topic, and both the Society of Economic Botany and the Second International Congress of Ethnobiology (to convene during the summer of 1990 in China) are expected to debate this issue soon. Janis Alcorn apprised the Board of some of the issues involved, and anticipated positive and negative effects of giving IPR to indigenous people through the *Journal*. There was a lengthy discussion, including whether or not we as a Society will want to make a statement on IPR. It was decided that the News and Comments section of the *Journal* is an appropriate outlet for members to begin a dialogue on this issue.

The appointment of a committee to look into matters relating to ethics was considered to be an issue for the Board of Trustees. This matter will be referred to them.

The three hour meeting was adjourned by Willard Van Asdall.

—Recorded by Karen Adams

SOCIETY OF ETHNOBIOLOGY
SECRETARY/TREASURER'S REPORT

March 5, 1990

Date of Last Report: April 1, 1989

Funds in Account at Last Report	$15,206.28

INCOME SINCE LAST REPORT:

Sale of Back Issues of *Journal*	$ 740,00
Dues: Volume 8	280.00
Volume 9	2,754.00
Volume 10	7,360.00
Volume 11	40.00
Author's Reprints	465.00
1986 Conference Income	759.00
1988 Conference Income	804.00
Donations to Lawrence Fund	100.00
Donations to Smith Fund	315.00
T-shirt Income	397.00
Interest	793.00
Total Income since Last Report	$14,807.00

EXPENSES SINCE LAST REPORT:

Production of *Journal:*

	Printing	Typesetting	Postage
Vol. 9, No. 1	$ 5,429	$2,112	*
Vol. 9, No. 2	$ 5,746	$2,016	*
Sub-Totals	$11,175	$4,128	—

Total Production Cost	$15,303.00

Other Expenses:

Interest on Weber loan	$ 420.00
Dancers at 1989 Conference	300.00
T-shirt production cost	108.00
Miscellaneous	86.00
Total Expenses	$16,217.00
TOTAL FUNDS IN ACOUNT AS OF MARCH 5, 1990	$13,796.28

JOURNAL CIRCULATION HISTORY TO DATE SINCE VOLUME 6:

Volume 7	414
Volume 8	439

Volume 9	**401
Volume 10	**265
Volume 11	** 2

*Paid for by the Department of Anthropology, Northern Illinois University.
**Not yet closed out.

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed double-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses*, i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Arizona State Museum, Building 26
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal*. Please send suggestions, comments, or reviews to one of the *Journal's* book review editors. Please see inside front cover for names and addresses.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Catherine S. Fowler, Department of Anthropology, University of Nevada, Reno, NV 89557. Subscription rates are $60.00, institutional; $25.00, students and foreign subscribers; $35.00, regular members from the U.S.and Canada; foreign subscribers add $8.00. Write checks payable to *Journal of Ethnobiology*. Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

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Journal of Ethnobiology

VOLUME 10, NUMBER 2 WINTER 1990

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Journal of Ethnobiology is published semi-annually. Manuscripts for publication, information for the "News and Comments" and book review sections should be sent to the appropriate editor on the inside back cover of this issue.

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VOLUME 10, NUMBER 2

WINTER 1990

In Memoriam

In fond memory we dedicate this issue of the *Journal of Ethnobiology* to Dr. C. Earle Smith, Jr. As a highly regarded scholar of botany and archaeological botany, "Smitty" also possessed a warm and outgoing personality that drew people to him. I have a vivid memory from my student days when I first met Smitty at an academic meeting. He, along with Volney Jones and Dick Ford, had invited fledgling archaeobotanists to an evening gathering, and Smitty was going around and introducing us to one another. His ruddy smile and pleasant nature relaxed even the most petrified amongst us.

Smitty's students David Lentz and Charlotte Gyllenhaal (1988) and Emily McClung de Tapia (1989) have provided us a thorough overview of his impressive academic accomplishments. Emily also took the time to organize his published and unpublished works, and offers a specific look at his contributions to Mexican ethnobotany (this volume). A brief scan of his bibliography reveals that, in addition to primary research, he enriched his profession with biographical sketches, book reviews, and synthetic works. His views on sharing information are revealed by his publications in foreign language journals and outlets.

I would like to share with you some common threads that weave throughout the papers in this volume that reflect Smitty's own interests and his approach to the profession of ethnobiology. I think that he would be proud of the diversity of research interests and scholarship expressed by these authors.

Bob Bye and Eldemira Linares expand upon Smitty's interests in human-plant interactions by examining the continuity or disjunction of the biological products of five tropical market plants over a four century period in central Mexico. Smitty understood that efforts to document ethnobotanical processes are often grounded in baseline archaeological contributions such as those he made. Although farther removed in subject matter and geographical area, Brian Hesse makes a similar contribution to understanding ethnobiological processes, this time in the form of prehistoric human-fauna interactions. He examines 4000 years of Palestinian archaeological records in light of diverse modern theories on the origins of the food tradition of pork prohibitiion.

Smitty's pioneering efforts in Central and South American archaeobotany required major investments in learning the modern flora of foreign regions, and in becoming familiar with both the archaeological and ethnographic literature. David Lentz so aptly contributes to and continues this research tradition with his multi-faceted look at the use of coyol by pre-Columbian Mesoamericans.

The difficulty and care required in identifying ancient plant remains is a theme of some C. Earle Smith publications. These concerns are reflected in my efforts to document the criteria of identification of ancient reedgrass cigarettes and their contents. Pamela Ford, though working with artiodactyl carpals, shares the same scholarly goals of fully describing the modern alternatives and providing explicit criteria that can be understood and duplicated by others.

Smitty's bibliography reveals his interest in the history and development of the discipline of archaeobotany. Emily McClung de Tapia continues this theme in her personal perspective on Mexican ethnobotany, where she explores how some ethnobotanists aim to mesh the goals of pure science with important humanistic concerns. This view parallels our Society's current leading role in defining the dimensions of socially responsible research with native groups.

In this volume Richard Evans Schultes, Brian Hesse and Emily McClung de Tapia share with us insights into the nature of C. Earle Smith, Jr., the man and the scholar. I easily envision that on many occasions in the field Smitty probably grabbed a nearby stick and smoothed a patch of dirt to sketch something by way of explanation. I do it myself, and am honored to be able to sketch for you this perspective on his contributions, research goals, and the interests he shared with many of us. If an "Ethnobotanical Hall of Fame" existed, he would surely be inducted.

Karen R. Adams

LENTZ, DAVID L. and CHARLOTTE GYLLENHAAL. 1988. C. Earle Smith, Jr., 1922–1987. Economic Botany 42(2):284–285.

de TAPIA, EMILY McCLUNG. 1989. In Memoriam. Journal of Ethnobiology 9(1):115.

DEDICATION

This issue
Volume 10, Number 2
of the
Journal of Ethnobiology
is dedicated to the memory of

C. EARLE SMITH, JR.

(1922–1987)

The Editorial Board of the *Journal of Ethnobiology* and the Board of Trustees and officers of the Society of Ethnobiology wish to acknowledge those who contributed to the C. Earle Smith, Jr. memorial fund, which helped to defray the publication of this issue. Our thanks to:

Leonard Blake • Jack Harlan • Lawrence Kaplan
Donald Lawrence • David Lentz • Emily McClung de Tapia
Naomi Miller • Shelia Pozorski • Elizabeth Reitz
Marie Standifer • Elizabeth Wing

PUBLISHED AND UNPUBLISHED WORKS OF C. EARLE SMITH, JR. 1922-1987

Compiled by
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México, D.F., México

J. Ethnobiol. 10(2):113–117 Winter 1990

PUBLISHED AND UNPUBLISHED WORKS

C. EARLE SMITH, JR.
1922-1987

1948—*Potamogeton bicupulatus* in Massachusettes. Rhodora 50:304.

1949—New archaeological evidence on the evolution of maize (with P.C. Mangelsdorf). Botanical Museum Leaflet 13:213–247. Harvard University.

1949—A discovery of prehistoric maize in New Mexico (with P.C. Mangelsdorf). Journal of Heredity 40(2).

1950—Prehistoric plant remains from Bat Cave. Botanical Museum Leaflet 14:157–180. Harvard University.

1953—The identity of *Valentinia ilicifolia* Swartz (with R.A. Howard). Journal Arnold Arboretum 34:176–181.

1954—The New World species of *Sloanea* (Elaeocarpaceae). Contributions Gray Herbarium 175. 114 p.

1955—Una carta inedita del maestro Guillermo Valencia (with R.E. Schultes). Agricultura Tropical 11:471.

1957—A century of botany in America. Bartonia 28:1–30.

1958—Airmen in the jungle. Frontiers 23:35–38.

1959—Thomas Nuttall (1786–1859): An evaluation and bibliography (with J.W. Thieret). Leaflets of Western Botany 9:33–42.

1959—An English obituary account of Thomas Nuttall (Concluding Part) (with T.W. Thieret). Bartonia 29:10.

1959—A personal herbarium for the home. Chicago Natural History Museum Bulletin 30:100–112.

1960—Birnum wood comes to Dunsinane. Chicago Natural History Museum Bulletin 31:4–5.

1960—A revision of *Cedrela* (Meliaceae). Fieldiana: Botany 29:295–341.

1962—Elaeocarpaceae. *In* Botanical Novelties in the Region of Sierra de Lema, Estado Bolivar. Sociedad Venezolana de Ciencias Naturales Boletin 23:70–73.

1962—Henry Muhlenberg–botanical pioneer. Proceeding American Philosophical Society 106:443–460.

1963—Your cooperation is requested. Staff Notes, NCRB. USDA. January.

1963—Something old, something new—farm practices near Tehuacan, Mexico. Economic Botany 17:200–210.

1963—A committee on terminology for hybrids (with E.E. Terrell). Taxon 12:293.

1964—Nomenclatural confusion in *Gossypium*. International Botanical Congress Abstract Paper 475–476.

1964—How dead, how soon? Bioscience 14:15–16.

1964—Antiquity of American polyploid cotton (with R.S. MacNeish). Science 143:675–676.

1965—Agriculture. Tehuacan Valley. Fieldiana: Botany 31:55–100.

1965—Plant fibers and civilization—cotton a case in point. Economic Botany 19:71–82.

1965—Flora of Panama, Part IV. Fam. 92. Meliaceae. Annals Missouri Botanical Garden 52:55–79.

1965—Flora, Tehuacan Valley. Fieldiana: Botany 31:101–143.

1965—Species indistinction in the genus *Vitis*. Leaflets of Western Botany 10:143–150.

1965—Garbage is golden. Chicago Natural History Museum Bulletin 36:6–8.

1965—Early archaeological maize from Venezuela (with Mario Sanoja O.). Botanical Museum Leaflet 21:105–112.

1966—Flora of Panama. Part VI. Fam. 113. Elaeocarpaceae. Annals Missouri Botanical Garden 52:487–495.

1966—Archaeological evidence for selection in avocado. Economic Botany 20:169–175.

1966—Identity of witchweed in the southeastern United States. Rhodora 68:167.

1966—Bibliography of American archaeological plant remains (with E.O. Callen, H.C. Cutler, W.C. Galinat, L. Kaplan, T.W. Whitaker, and R.A. Yarnell). Economic Botany 20:446–460.

1967—Elaeocarpaceae. Flora del Auyan-tepui. Acta Botanica Venezuelica 2:244–246. [J.A. Steyermark (editor)].

1967—Plant remains. Pp. 220–225 *in* D.S. Byers (editor). The Prehistory of the Tehuacan Valley. University of Texas Press. V.I. Austin.

1968—Archaeological evidence for selection of Chupandilla and Cosahuico under cultivation in Mexico. Economic Botany 22:140–148.

1968—The New World centers of origin of cultivated plants and the archaeological evidence. Economic Botany 22:253–266.

1968—Boll Weevil found in pre-Columbian cotton from Mexico (with R.E. Warner). Science 162:911–912.

1968—Pre-conquest plant fibers from the Tehuacan Valley, Mexico (with T. Kerr). Economic Botany 22:354–358

1969—From Vavilov to the present—a review. Economic Botany 23:2–19.

1969—Additional notes on pre-Conquest avocados in Mexico. Economic Botany 23:135–140.

1969—Pollen characteristics of African species of *Vernonia*. Journal Arnold Arboretum 50:469–477.

1970—Elaeocarpaceas (with L.B. Smith). *In* Florula de Ilha de Santa Catarina 28. R.J. de Souza Sobrinho and A. Bresolin (editors). Florianopolis, Brazil.

1970—Elaeocarpaceas (with L.B. Smith). *In* Flora Ilustrada Catarense 33. P.R. Reitz (editor). Santa Catarina, Brazil.

1971—Critical identification of Mexican archaeological cotton remains (with S.G. Stephens). Economic Botany 25:160–168.

1971—Observations on Stengeloid species of *Vernonia*. United States Department of Agriculture Handbook 396.

1971—The preparation of herbarium specimens of vascular plants. United States Department of Agriculture Information Bulletin 348.

1972—The contributions of Agostino Todaro to *Gossypium* nomenclature (with P.A. Fryxell). Taxon 21:139–145.

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n.d.—Plant remains from Mississippi site 22La 513.

n.d.—Archaeological plant remains from West Alabama.

n.d.—Botanical remains from the Y site.

n.d.—Plant remains from 1 Je 34.

n.d.—Plant remains from 1 Je. 35.

n.d.—Plant remains from sites 1 Je 31, 32 and 33.

n.d.—Pre-Conquest plant remains from the Oaxaca Valley.

n.d.—Pre-Ceramic plant remains from the Oaxaca Valley.

n.d.—Vegetal remains from Tomaltepec (B-176).

n.d.—The Tierras Largas (B-74) vegetal remains.

n.d.—Carbonized plant remains from San Jose Mogote (OS-62).

n.d.—The vegetal remains from Abasolo (B-153).

n.d.—The plant remains from Barrio Rosario Huitzo (B-46).

n.d.—Prehistoric changes in dietary plants in eastern North America and Mexico.

n.d.—Notes on archaeological plant remain identifications in Costa Rica and Peru.

n.d.—Floral remains from La Galgada, Peru.

n.d.—Prehistoric plant use in the middle Orinoco Basin: collectible resources (with A.C. Roosevelt).

BOOK REVIEW

Edible Wild Plants of the Prairie: an Ethnobotanical Guide. Kelly Kindscher. Lawrence: University Press of Kansas, 1987. Pp. x, 276. $25.00 (cloth), $9.95 (paper).

This book discusses 86 plants native to the prairies of central North America. Many of these plants are found in other parts of the continent as well. For each species, the author gives English, native, and scientific names, a brief description of the plant's morphology, habitat, and food uses, and a history of the plant's cultivation, if any. Many of the descriptions are accompanied by line drawings and range maps.

This book is semi-popular in nature, containing much information useful to the professional yet accessible to the non-specialist as well. It is well-referenced and more authoritative than many similar works on edible plants. The author is well-versed in the ethnobotanical literature and uses it to great effect.

If the book has a flaw it is that only a few plants are compared to poisonous look-alikes. No drawings of poisonous plants are included for comparison. Nevertheless, I highly recommend the book as a valuable reference.

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HOW I MET C. EARLE SMITH

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In 1941, when I had received my PhD from Harvard University, I had the opportunity to go to the Colombian Amazon on a National Research Council grant to begin ethnobotanical work, especially on the components of curare or arrow poisons.

The Indians of the northwestern part of the Amazon had the reputation of preparing unusually potent curares and many different types of curare according to the kinds of animals that the hunters wanted to kill. Furthermore, there were suggestions that the natives of this region employed plants unknown elsewhere as curare components.

Immediately before I was to leave, I had a call from the late Professor Elmer D. Merrill, director of the Arnold Arboretum at Harvard University. He said, "I have $500 left from a grant. I also have a very promising undergraduate whose one ambition is to prepare himself to be an ethnobotanist in the tropics. I am deeply impressed with this young man whose name is C. Earle Smith. Would you be willing to interview him and possibly take him on your expedition to Colombia as a helper? I am sure that he can learn much more with you in the field than he can from any lectures or books."

That afternoon, "Smitty," as he was known amongst his fellow students, phoned me and told me that Dr. Merrill had suggested that he request an interview with me. We arranged the interview. I had already half decided in my own mind that it might be advantageous to the student and to me, since I knew that Professor Merrill had a well known and uncanny ability to "size up" students. It was this aspect of his perspicacity that influenced my pre-interview thinking.

Smitty appeared, and we had a most cordial interview. I immediately realized that here was a young many fully determined to dedicate his life's work to tropical ethnobotany. I told him then and there to prepare for the trip and to follow me as soon as he could leave. He left overjoyed.

There was one point in the interview that impressed me more than anything else. Even in 1941, $500 would not go far in travel and living. I pointed this out to Smitty. Dr. Merrill had told me that Smitty was working his way through Harvard. Smitty informed me that he had saved up $350 that year and that, since he was going to take half a year off, he would put this towards the $500 that Dr. Merrill had offered. I knew that once we got out of cities and into Indian country our expenses would not be high, and I decided then to help this young protegé from my own grant should he turn out to be as promising as we suspected he might be.

I had my reservations to Colombia, and they could not be changed without an extra charge. But Smitty was so anxious to go that within ten or twelve days he followed. In the meantime, I had found in Bogotá a lovely but inexpensive

British boarding house run by an elderly and motherly English lady who had spent years in Colombia. We spent several weeks, Smitty and I, in Bogotá getting used to the high altitude, collecting plants in the high moors or *páramos* on the moutains surrounding Bogotá, working in the National Herbarium and becoming acquainted with the very friendly and helpful staff of the Institute of Natural Sciences. Soon we had preparations made for our trip south and into Indian country.

We went by bus, the least expensive way—a five-day trip to the small city of Pasto near the Ecuadorean border. From Pasto, we went east to the high mountain-girt Valley of Sibundoy, inhabited by several thousand Kamsá and Inga Indians. The Capuchín missionaries, interested in native anthropology and ethnobotany themselves, welcomed us with open arms and set us up in an extra room in their large school. We collected in this beautiful valley, where the Indians still had impressive knowledge of medicinal plants, for several weeks, assisted by the missionaries and the native medicine men.

One young Kamsa boy, especially knowledgeable about the plants and their local uses and names, showed extreme interest in our work. When it was time to leave Sibundoy, he asked if he could accompany us to learn more and to see the forests of the lower warm country to which we were headed. His father agreed that he go with us but that he return immediately, because he did not want the boy to be exposed in the hot country to malaria. It turned out to be a great boon for both of us, especially for Smitty who, for the first time, could experience working with a native Indian and appreciate their profound knowledge of the properties of the plants of the ambient vegetation.

Again we were welcomed by the Catholic missionaries in the town of Mocoa. Through their good will and help, we were introduced to a German who had spent many years in the Colombian Putumayo, the State of which Mocoa is the capital. The Putumayo has a very heavy Indian population, with a number of different tribes represented: Inganos, Sionas, Kofáns and other smaller groups. A number of Indians of various tribes worked for the priests and for the German who had extensive agricultural holdings. We were able to make extensive ethnobotanical collections. Smitty was such a dedicated helper and was learning so much about the many tropical families and genera and becoming so adept in gathering ethnobotanical data from the natives that I resolved to have him accompany me as I penetrated deeper into the northwest Amazon where Indians were less acculturated.

Unfortunately, news of Pearl Harbor came over the radio in the priests' residence after a month's work that we were able to accomplish in the Mocoa region. Smitty decided to return to Bogotá and then back to Boston. He signed up with the navy, I understand. I was assigned to return to the Amazon to help on the programme of procurement of rubber from wild trees for the war effort, as the Japanese had by that time taken over all of the British and Dutch colonies and their rubber plantations. I remained for the following twelve years in the Amazon and did not see Smitty until the 1960s, when he had earned his doctorate and was well on the way to becoming one of the outstanding ethnobotanists of this century. His greatest contribution probably was his extensive research in archaeoethnobotany, but as a professor in the University of Alabama he trained

a number of ethnobotanists and returned to the Colombian Amazon to initiate ethnobotanical studies among the Tikuna Indians in the region of Leticia. He turned this study over to one of his excellent students who eventually published a summary of the plant uses of this famous tribe. With all his teaching and research, he found time to serve on committees and to attend meetings in which he read papers on his research in ethnobotany and economic botany.

When the International Botanical Congress met in Seattle in 1969, I was asked to chair the section on Ethnobotany. Following the Congress, the papers read in this Section were published in book form. Who did the editing and preparation of the manuscripts but my helper of many years before in the Putumayo—Smitty!

Smitty's death in an automobile accident represents a tragic loss for the fast-developing field of ethnobotany. Had he lived, there is no doubt that ethnobotanical progress would have profitted greatly not only from his own insatiable spirit of research but also for his training of students in this field that so desperately need specialists in view of the ever more rapid loss of ethnobotanical knowledge in primitive societies as a result of acculturation and westernization in many parts of the world.

I have often thought how fortunate I was in heeding Professor Merrill's suggestion and how happy I was in my short collaborative field work with Smitty. Although I was in a way his teacher, he certainly taught me much in that brief period of joint research among the Indians of Colombia's Putumayo.

I wish to acknowledge the assistance of Joseph Laferriere, who, as a service to the Society and *Journal of Ethnobiology,* has translated the abstracts of many articles into French, and even one or two into Spanish. Joe's abilities in these languages, especially French, and his willingness to help, have enabled the editorial staff to publish the *Journal* in a timely fashion. I am pleased to both acknowledge the help Joe has given and to thank him for it.

Willard Van Asdall, Editor

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PREHISTORIC REEDGRASS *(Phragmites)* "CIGARETTES" WITH TOBACCO *(Nicotiana)* CONTENTS: A CASE STUDY FROM RED BOW CLIFF DWELLING, ARIZONA

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ABSTRACT.—Tubular culm (stem) segments of a hollow, robust grass (Gramineae), one end filled with plant material, have preserved in caves and rockshelters representing a variety of cultural traditions in the Greater Southwest. These items, commonly referred to as "reedgrass cigarettes," are generally presumed to represent ritual smoking. A study of twelve cigarettes from Red Bow Cliff Dwelling in Arizona provided the impetus to summarize anatomical and morphological criteria for distinguishing *Phragmites* from *Arundo* culms, as well as to delineate features that permit segregation of some species of tobacco *(Nicotiana)* when only stem fragments are recovered. The body of each Red Bow cigarette was formed from a stem of *Phragmites australis* (reedgrass). Broken stems similar to *Nicotiana attenuata,* a native tobacco, comprised the filling material of at least four specimens.

RESUMEN.—Segmentos huecos de un culmo tubular (tallo) de un zacate robusto (Gramineae), una terminación llena con material vegetal, lue preservado en unas cuevas y lechos de roca representando una variedad de tradiciones culturales en el gran Suroeste americano. Estos articulos comunmente son referidos como "cigarros de carrizo," se piensa generalmente que representan rituales de fumar. Un estudio de doce cigarros del Red Bow Cliff Dwelling en Arizona proveen de impétu para resumir criterios anatómicos y morfológicos para distinguir los culmos de *Phragmites* de *Arundo,* asi como para delinear caractertísticas que permitan separar algunos especies de tabaco. El cuerpo de cada cigarro de Red Bow fue formado del tallo de *Phragmites australis* (carrizo). Un tallo roto similar a *Nicotiana atteniuata,* un tabaco nativo, comprendio el material de relleno de por lo menos cuatro especimenes.

RESUME.—Quelques segments tubulaires des tiges creux robustes gramineés, avec un bout bourré d'herbage, se sont préservés dans les cavernes et les abris rocheux d'un gran variété de traditions culturels du Grand Sud-ouest. Cettes choses, communément appellées comme les "cigarettes de roseaux," se présument généralement comme des appareil de fumer rituellement. Une étudie de douze spécimens du Red Bow Cliff Dwelling en Arizona nous a inspiré à résumer des critères anatomiques et morphologiques por distinguer des tiges de *Phragmites* de ceux de *Arundo.* Nous discoutons aussi les traits qui permittent que l'on distingue entre quelques espèces du tabac *(Nicotiana)* quand on ne recouvre que des fragments des tiges. Le corps de chaque cigarette de Red Bow s'est formé d'un tiges du roseau *(Phragmites australis).* Des tiges rompés semblables à ceux d'un tabac natif *(Nicotiana attenuata)* comprend la tripe d'au moins quatre spécimens.

INTRODUCTION

Large numbers of "reedgrass cigarettes," alternatively referred to as "cane cigarettes," "ceremonial cigarettes," "tubular pipes" or "prayer tubes," have preserved in prehistoric caves and rock shelters representing a diversity of cultural traditions and geographical locations in the Greater Southwest. Their presence in Mogollon, Anasazi, Hohokam, and Salado sites, and from prehistoric locations in the Great Basin, the Trans-Pecos area and Mexico has been summarized by Grange (1952:353–354) and Switzer (1969). Grange suggested that Mogollon groups were the first to utilize these items, and pointed out that each cultural group employed distinctive methods to embellish and decorate them.

This study reviews the literature on reedgrass cigarettes and adds a botanical dimension to the cultural, geographical and chronological information already available. While there is no reason to suspect that the majority of previous identifications of this artifact class are incorrect, this research contributes a set of anatomical and morphological criteria that enhances replicability in identification. In an attempt to recognize the material of cigarette body construction, criteria were established in which the robust, hollow stems of reedgrass *(Phragmites australis* (Cav.) Trin. ex Steudel. as *Phragmites communis* Trin.)[1] could be distinguished from those of the giant reed *(Arundo donax* L). An ethnobotanical summary of diverse taxa and parts smoked in historic times provided a starting point for an attempt to identify the cigarette filler material. One contribution has been to delineate some of the differences between stems of two native *(Nicotiana attenuata* Torr., *N. trigonophylla* Dunal.) and one domestic species of tobacco *(Nicotiana rustica* L.).

Typical Construction.—Regardless of affiliation or location, "reedgrass" cigarettes are similarly constructed (Fig. 1). In most cases the body has been formed from

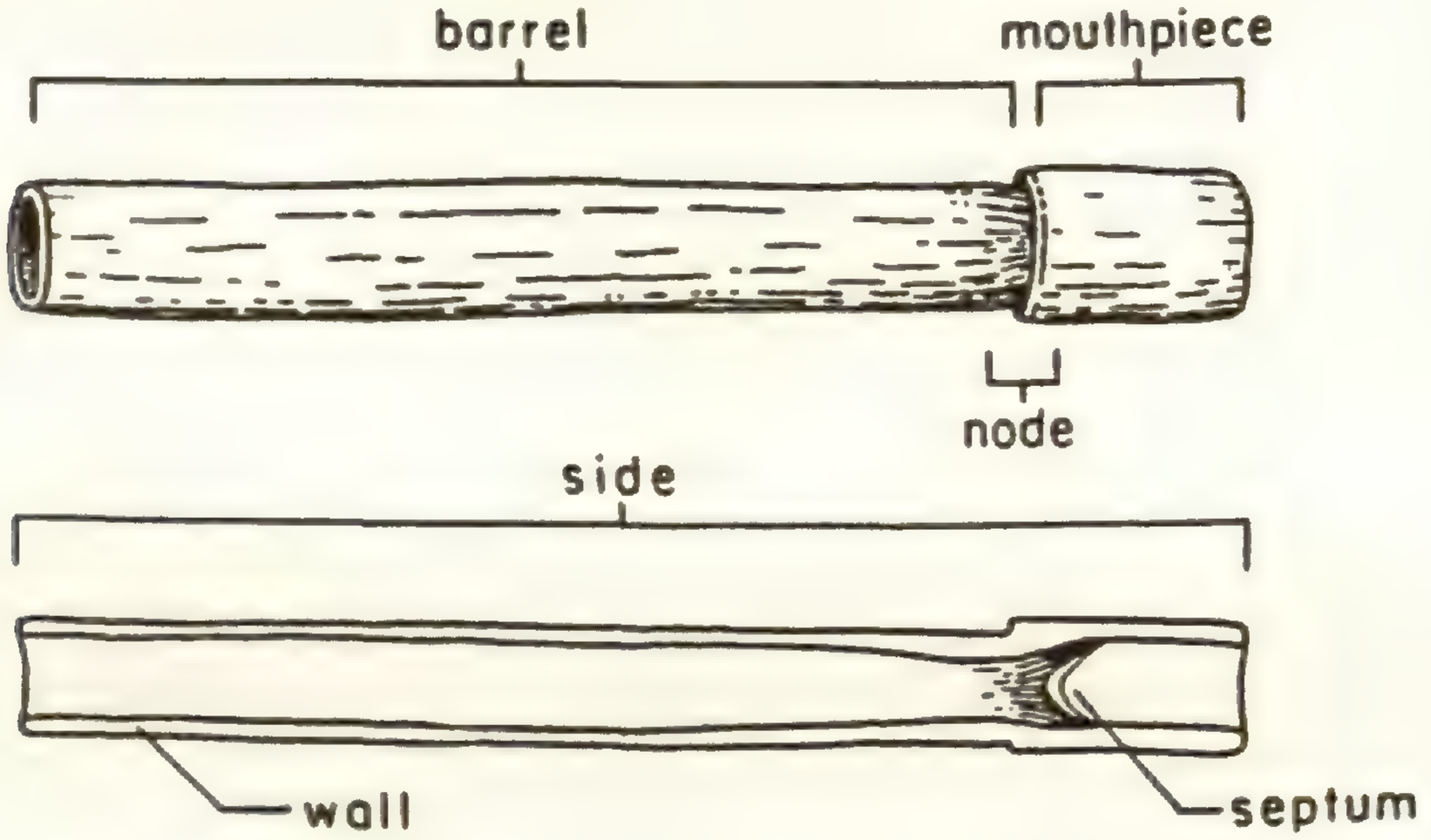


FIG. 1.—Features of cigarette body, adapted from Switzer (1969:37). The "barrel" is sometimes referred to as the "bowl."

the stem (culm) of a robust, hollow grass by first pulling off the leaves, and then by making two right angle cuts to detach a segment. The resulting hollow chamber is divided into a longer "barrel" and a shorter "mouthpiece" by the presence of a natural internal septum (a partition or cross wall) nearer one end. The size range of cigarettes can vary considerably. For example, metric data available on over half (n=752) of a very large (n=1200+) collection of specimens from Red Bow Cliff Dwelling in Arizona reveal they range from 15–205 mm in length and from 4–19 mm in diameter (Gifford 1980:78).

The Cigarette Body.—Specific criteria of identification for the cigarette body have not been reported in the literature. When a scientific name for the grass is noted, it is almost invariably *Phragmites* or *Phragmites australis* (as *Phragmites communis),* a robust, hollow stemmed reedgrass that grows in riparian habitats in the West. In one location, however, the cigarettes from Fate Bell Cave along the Pecos River in Texas were said to be constructed from lengths of *Arundo donax* (Switzer 1969:43), an Old World species presumably introduced into the Americas in historic times (Gould 1951:93).

Variation in the condition of these cigarettes is notable (summarized in Grange 1952:351–354). Some have had a small hole pierced through the septum, apparently to permit the passage of air. Many others remain unpierced. Some have been burned on the "barrel" end, or all along the length, yet many remain unburned. Others were painted or wrapped with woven cotton sashes and sometimes tied together in groups (Haury 1945:195), or had small beads attached or were tied to miniature bows (Grange 1952:351–354).

The Cigarette Contents.—The broken or pulverized plant material present in the longer "barrel" portion of many specimens has been the subject of great interest, but of few detailed analyses. As with the material of cigarette body construction, the anatomical and morphological criteria of identification of the contents are not given. Hough (1914) commented that the contents of cigarettes in the Upper Gila region were composed of fragments of aromatic herbs, such as "artemisia," and other plants not determined. Haury noted that the chief substance in cigarettes of Double Butte cave was of a woody nature, highly charged with pitch, and possibly representing the scaly bark of "ocatilla" (1945:194). Smoking materials listed for other locations include "red willow" (Bandelier 1890:49–50), *Larrea* (Jones 1935:289) and "cedar" (Coffin 1932:32).

Identifications of the cigarette contents as native species of tobacco (e.g. *Nicotiana)* can also be found. In the Hohokam area, Fewkes noted early in this century that "A small dish containing native tobacco *(Nicotiana attenuata)* was found in one of the rooms" at Casa Grande pueblo (1912:143). Jones later (1935:289) identified *Nicotiana attenuata* in ceremonial cigarettes from this same site. For the Mogollon region, Grange (1952:418) listed small dried stems of *N. attenuata* in a few reed cigarettes from Tularosa Cave, and Cosgrove reported similar material from caves in the Gila and Hueco areas (1947:121). An extensive Anasazi record of *Nicotiana* use (though not specifically in reedgrass cigarettes) has been summarized by both Winter (1990) and Adams (1990).

There are limited records to the recovery of domesticated species of tobacco in Southwestern sites. Some of the Double Butte Cave specimens in Arizona were noted to have highly pulverized and oxidized leaves of *Nicotiana tabacum* (Haury 1945:194), though this identification seems problematical since *N. tabacum* was presumably unknown north of Mexico in aboriginal times (Setchell 1921:401). The seeds of *Nicotiana rustica,* previously known from Middle and Late Woodland agricultural contexts in the eastern United States (Ford 1981:19; Asch and Asch 1985:195), have also been reported from ancient Hohokam sites in Arizona (Miksicek 1983a, 1983b, 1983c, 1984, 1986; Miksicek and Gasser 1989), although these records lack detailed identification criteria.

Cigarette Function.—Different opinions as to the function of reedgrass cigarettes have been offered. A primary opinion is that they served ceremonial needs through time and across space (Jones 1944:455). This suggestion is based not only on the fact that none (Haury 1945:194) or few (Gifford 1980:78) of the cigarettes at some prehistoric sites show any evidence of having been smoked, but also on the associated sacred paraphernalia that often accompanied them (Gifford 1980:11). Support for this idea comes via reports that reedgrass cigarettes have often been used by Southwestern U.S. historic groups to provide smoke to make a path for prayer to the gods, or to provide for the general good of the tribe (Bohrer 1962:87). Such cigarettes, often deposited in shrines, were barely touched with a live coal as an offering for supernaturals (Switzer 1969:40); such a practice might leave many reeds uncharred except for the end.

An alternative view of cigarette function was expressed early in this century by Linton (1924:9). He suggested that some of the prehistoric reedgrass cigarettes with completely charred barrels probably represented smoking for personal pleasure. Personal satisfaction is listed as the reason why the Seri in Sonora, Mexico currently smoke parts of native plants, including *Nicotiana,* in reedgrass pipes (Felger and Moser 1985:165).

Use of reedgrass for alternative purposes would not produce items with precisely the same characteristics as cigarettes. For example, flutes and gaming pieces require stem segments with multiple or no septa, and are often embellished with additional perforations and designs (Russell 1975:166, 176). Arrowshafts might display characteristics such as tapering, notches, or reinforcement with additional pieces of reed or wood (Coffin 1932:31–32).

The Problem.—Detailed analyses of this class of artifacts has been neglected, in part because of the difficulties involved in identification of fragmented barrel contents. Nevertheless, it would be valuable to know something about the range of materials conceived useful as the filling for reedgrass cigarettes, and to know if only one type of robust grass was routinely chosen to form the cigarette body.

METHODS AND RESULTS

A pilot study employing morphological and anatomical criteria has been undertaken to these ends. A small sample of twelve uncharred cigarettes were chosen from the hundreds recovered from the Red Bow Cliff Dwelling, an A.D.

1325–1400 Mogollon/Pueblo site in the Point of Pines region 65 miles east of Globe, Arizona (Gifford 1980). Red Bow is a 5-room cliff dwelling with evidence of both ceremonial and domestic activities. The cigarettes chosen for this study were all from Room 4, which contained numerous items considered to represent ceremonial paraphernalia (Gifford 1980:24).

Description of the Body of Red Bow Cigarettes.—In all cases, the cigarette body consists of two hollow internodes linked at a node (with internal septum) which is located nearer one end than the other. The longer end will be referred to as the "barrel" and the shorter internode the "mouthpiece," according to terminology suggested by Switzer (1969:37). The twelve specimens vary in length from 3.0–11.1 cm, range from 0.9 to 1.3 cm in diameter, and are generally round in cross section (Table 1).

TABLE 1.—*Red Bow "cigarette" body dimensions and data. Organized from longest to shortest specimen.*

Cigarette No.	Length (cm)	Diameter (cm)	# pieces in barrel	No. of cuts Distal	Proximal	U.A. Number
1	11.1	1.0 x 1.1	2	3	3	A–17021x
2	9.6	1.0 x 1.0	4	8	8	A–17025x
3	9.0	1.0 x 1.1	4	8	7	A–17025x
4	8.3	1.2 x 1.3	3	12	5	A–17021x
5	8.0	1.1 x 1.1	4	2	2	A–17046x
6	7.9	1.3 x 1.4	3	4	3	A–17020x
7	4.4	1.3 x 1.4	3	6	7	A–17025x
8	3.8	1.1 x 1.1	7	4	5	A–17021x
9	3.8	.9 x .9	7	2	2	A–17025x
10	3.8	.9 x 1.0	5	3	1	A–17020x
11	3.0	1.0 x 1.1	5	8	6	A–17021x
12	3.0	.9 x 1.0	7	1	2	A–17017x

For eleven specimens the "mouthpiece" of the cigarette corresponds to the proximal end of the stem, and the "barrel" comprises the distal end; the reverse is true only for specimen #8. The nature of both the proximal and distal ends revealed that the common method of preparation was to make a series of small cuts around the circumference of a stem, then apply pressure to snap the specimen free. In two specimens (#10 and #12) a single continuous cut was made, perhaps by rolling the stem on a hard surface while applying pressure with a cutting implement. The septum of each specimen has been pierced to produce a round, small (1–2 mm diameter) hole.

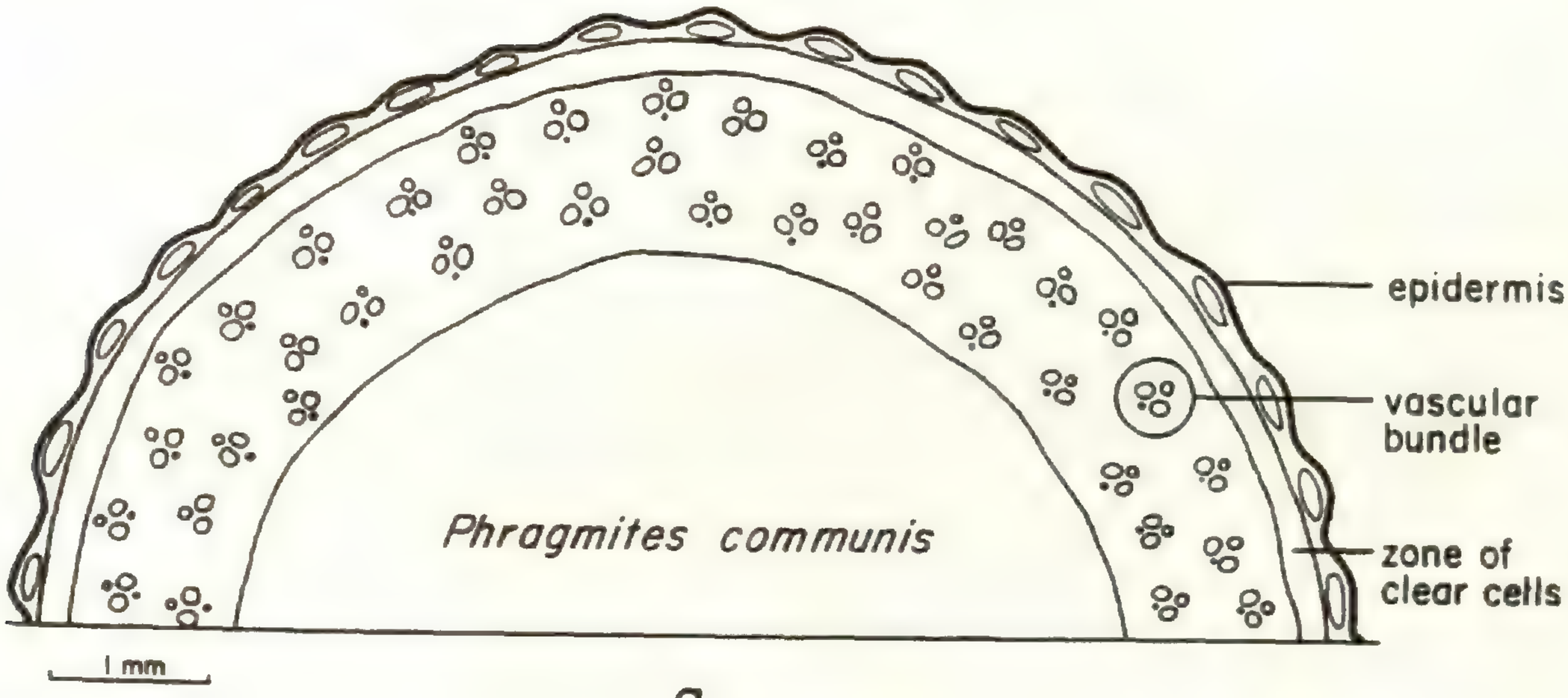
Identification of the Body of Red Bow Cigarettes.—The cigarette body of all 12 specimens represents stem material with the parallel veining and bundled arrangement of vascular tissue characteristic of plants known as monocotyledons. The sturdy stems have solid nodes (a node is a point where a leaf or bud arises) and hollow internodes. A small, raised elliptical area above the node in each specimen may represent an undeveloped bud.

The characteristics listed above suggest the Red Bow cigarettes were made from a species of grass belonging to the Festucoideae (Pooideae) subfamily, or to an additional smaller group of grasses including some in the subfamily Arundinoideae, all of which are characterized by large, hollow internodes (Brown *et al.* 1959:120). Within these subfamilies I believe there are only two species of grasses in the Southwest with sturdy stems over 1.0 cm in diameter. These include *Phragmites australis* (=*Phragmites communis)* and *Arundo donax*. Native *Phragmites* is widely distributed in the Southwest in moist locations below 6000′ (Gould 1951:93–94). Introduced *Arundo* grows best along irrigation ditches and watercourses in the southern portion of the United States and in Mexico (Gould 1951:93). Although considered a recent addition to New World flora, *Arundo* was included in this study for two reasons: (1) Southwestern rockshelters can contain organic materials of diverse age, and the Red Bow specimens have not been directly dated, and (2) on occasion archaeological deposits have revealed that taxa commonly considered to have been introduced historically were in fact present in an area in prehistoric times (Betancourt *et al.* 1984; Chapman *et al.* 1974).

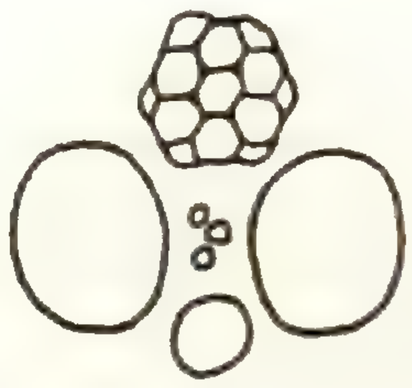
A comparison of the Red Bow specimens to modern *Phragmites* stems of similar diameter revealed close correspondence between them. Both had an elliptical bud scar above each node. Transverse (cross) section comparison of internodal segments reveal vascular and support tissue that occupies approximately ⅓ of the volume of the stem (Fig. 2a). The epidermis is subtended by a zone of clear (translucent) cells with thick lignified walls (sclerosed tissue). Interior to this clear zone, the vascular bundles are spaced in two-three rather irregular rows within a background of large, thin-walled parenchyma cells (see also Metcalfe 1960:386–387 and Stant 1953).

A comparison of the Red Bow specimens to modern *Arundo donax* culms was less satisfactory. The primary reason lies in the arrangement of vascular bundles in *Arundo,* which are in up to four or more irregular rows (Fig. 2b). *Arundo* grass also usually develops prominent side branches above many of its nodes, and in transverse section displays a much less prominent translucent layer of support tissue beneath the epidermis (see also Metcalfe 1960:48).

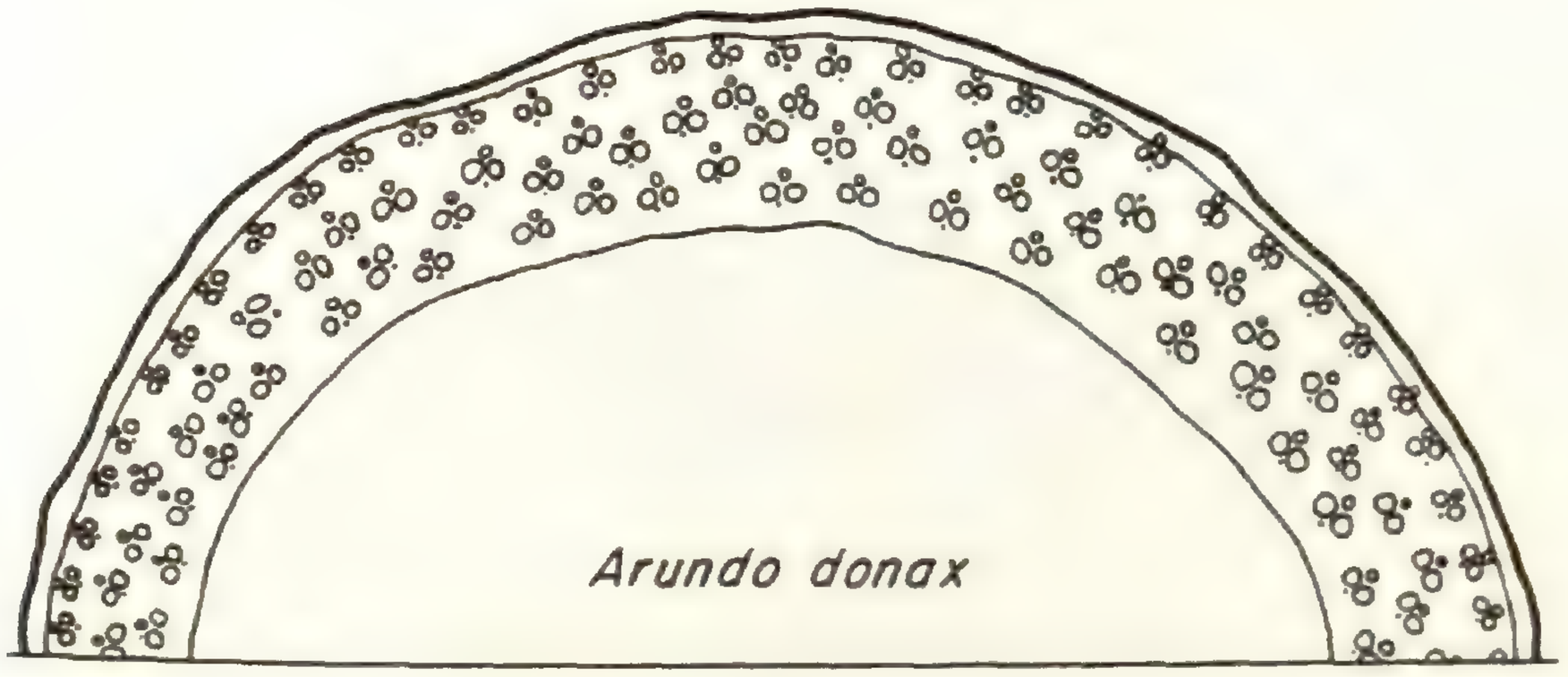
These anatomical and morphological criteria suggest that *Phragmites* is more likely the material of Red Bow cigarette body construction. It was gratifying to eliminate *Arundo* on the basis of anatomy and morphology, rather than to depend solely on its reputation as an historically introduced taxon. One might be able to further support this conclusion by evaluating phytoliths (microscopic mineral particles deposited within and around the cells of certain plants) that occur in the stems of both *Phragmites* and *Arundo;* at least one study (Ollendorf *et al.* 1988) reveals that phytoliths deposited in the leaves of these two genera are distinguishable.



a



enlarged vascular bundle



b

FIG. 2.—Transverse section of culms of equal diameter of a) *Phragmites australis* (Cav.) Trin. ex Steudel. (=*Phragmites communis* Trin.), and b) *Arundo donax* L., showing general arrangement of vascular bundles.

Apparently the relative strength of *Phragmites* stems can be influenced by harvesting (Stant 1953:237–238). Repeated cutting of reedgrass beds induces improvement in the strength of culms via increased lignification of cell walls, development of fewer internal air cavities, and increase in the length of fibers. These characteristics would tend to promote both rigidity and increased resistance to infiltration by decay organisms. It is within the realm of possibility that

prehistoric peoples were aware of the structural changes in *Phragmites* fostered by occasional management of a reedgrass stand.

Description of the Contents of Red Bow Cigarettes.—The contents of each barrel end of all 12 cigarettes were carefully extracted and examined. Care was taken in this endeavor, since five of the prehistoric tubular reed pipes identified by Jones (1935:289) were apparently filled in a certain order. In the case of the Red Bow specimens, from two to seven pieces of a single type of coarse material as long as the barrel had been packed parallel to the stem axis. The method of filling seems to have consisted of inserting a bundle of material into the barrel until it reached the septum, then breaking off any extra that lapped out over the end. This sole mode of packing applied to all twelve specimens.

Insect activity had extensively damaged the material inside most cigarettes. Insect body parts and frass (combination of plant debris/insect excrement) were observed in nearly every specimen. Often the frass had piled up against the septum, appearing to the naked eye like a fine powder. It might be possible to mistake this debris for minced plant material intentionally packed inside.

The following composite description generally characterizes the barrel contents of all twelve specimens examined at 50x magnification. No mature reproductive parts (fruit, seeds) or diagnostically valuable leaves or flowers were present. Rather, only stem segments and broken stem fragments were recovered. Pieces that are complete in circumference have a thin epidermis, a relatively narrow section of what appears to be xylem tissue, and a large interior area that is often empty but occasionally composed of large irregularly-shaped cells (Fig. 3). This pith region in many specimens has been replaced with insect frass. The xylem tissue contains round, thick-walled cells (fibers) where it joins the pith, and some larger conducting (?) vessels irregularly scattered among the background of small rectangular cells. The xylem ranges from 0.23–0.84 mm in width, comprising roughly one-tenth of the diameter of the stem. Phloem tissue cannot be distinguished. Narrow rays are present and abundant.

On a number of specimens there is clear evidence that the stems had an alternate branching pattern. The thin and narrow branches barely diverge from the main portion of the stem, but this appressed appearance may be partly due to the effects of packing. Occasionally two stuctures emerge simultaneously at a branch point; it is possible that the outer of these structures represents a long and narrow leaf petiole, while the inner structure is a side branch that has developed in the leaf axil.

The exterior surface of the barrel content material is diverse. Four specimens (#1, #2, #3 and #9) display short, glandular hairs (trichomes). These hairs are abundant in specimen #3, but have preserved only in a protected axil area in the other three. The contents of the remaining cigarettes have surfaces that are generally slightly wrinkled, but without hairs or other notable features.

Identification of the Contents of Red Bow Cigarettes.—The anatomical characteristics described above suggest that all the barrel contents represent herbaceous dicotyledons in a somewhat advanced state of growth (Esau 1977:306–309). The material

lacks the multiple growth layers typical of stems older than one growing season in age. It is likely the specimens derive from robust annual plants, or represent young growth in perennials.

To provide a starting point for the identification of the Red Bow cigarette contents, the modern ethnographic literature was surveyed for some of the materials smoked by historic groups. A variety of taxa and materials were gathered (Table 2), and the literature is especially rich in references to cultivation (Table 3) and use (Table 4) of *Nicotiana* species (for an extensive survey of North American tobacco use, see Winter 1990). Of the items listed in Table 2, parts such as conifer needles and minute feathers were easily eliminated from consideration. By direct comparison to herbarium material, the remainder of the Table 2 taxa were also eliminated because they were opposite-branching, lacked the appropriate proportion of pith, displayed no trichomes, had sessile or clasping leaves, or differed in other ways.

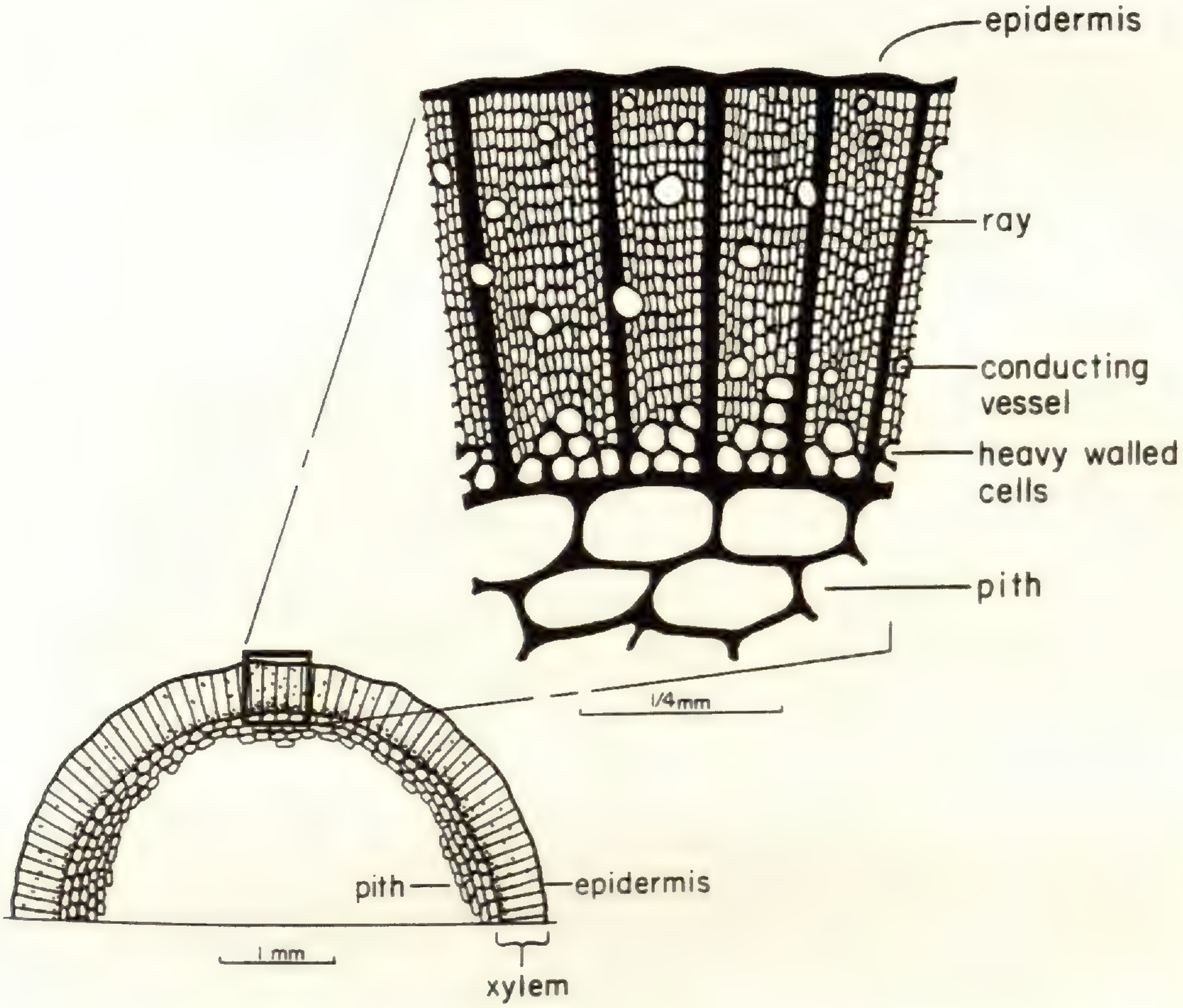


FIG. 3.—Composite drawing of the transverse section of stem segments that comprise the contents of Red Bow cigarettes.

TABLE 2.—*Smoking materials of some historic North American groups. Data on Nicotiana species are summarized in Tables 3 and 4.*

Taxon	Part	Group	Reference
Abies (fir)	needles	Hopi	Whiting 1966:62
Arctostaphylos (manzanita)	leaves	S. Paiute	Bye 1972:94
		Cochiti	Lange 1968:149
		Ramah Navajo	Vestal 1952:38
Eupatorium (thoroughwort)	leaves	Cochiti	Lange 1968:149
Mentha (mint)	plant	Kayenta Navajo	Wyman and Harris: 1951:40
Mirabilis (four o'clock)		Acoma/Laguna	Swank 1932:54
Oenothera (evening primrose)	flowers, roots, leaves, seed pods	Ramah Navajo	Vestal 1952:37–38
Onosmodium (false gromwell)	leaves, stems, flowers	Hopi	Whiting 1966:88
Pinus (pine)	needles	Hopi	Whiting 1966:63
Populus (cottonwood)		Hopi	Whiting 1966:71
Portulaca (purslane)	leaves	Tewa	Robbins, Harrington and Freire-Marreco 1916:72
Rhus (sumac)	leaves	Cochiti	Lange 1968:150
		Comanche	Carlson and Jones 1940:536
		Kiowa	Vestal and Schultes 1939:139–140
		Santa Ana	White 1945:563
Salix (willow)	leaves	Kayenta Navajo	Wyman and Harris 1951:18
Thalictrum (bedstraw)	plants	Spanish-Americans	Curtin 1965:177
Unknown	minute yellow bird feathers	Hopi	Stephen 1936:75, 172

The comparison of the Red Bow cigarette contents to modern *Nicotiana* plants provided the best match. Similarities in transverse section, branching, and the nature and distribution of trichomes suggested that at least some of the prehistoric

material represents tobacco stems, so detailed comparisons to modern tobacco species were considered appropriate. Of the four native species of *Nicotiana* listed for Arizona (Kearney and Peebles 1960:761), two of them (*N. palmeri* Gray and *N. clevelandi* Gray) grow lower than 3000 feet in elevation, and would not be found naturally in the Red Bow area. The annual *N. attenuata* Torr. and annual-perennial *N. trigonophylla* Dunal. grow throughout the state up to 6000′ and 7000′ respectively. Domesticated *Nicotiana rustica* L. was included in these comparisons due

TABLE 3.—*Historic references to tobacco cultivation in the west and southwestern United States.*

Group	Species	Methods	Reference(s)
Havasupai (AZ)	*N. trigonophylla*, *Nicotiana* sp.	Cut down mesquite tree, burn it; throw tobacco seeds in ashes	Spier 1928:105
Hopi (AZ)	*N. attenuata* *N. trigonophylla*	Scatter seeds on a favorable spot	Whiting 1966:16, 90
Papago (AZ)	*N. tabacum*?	Planted in desert wash; much care given	Castetter and Bell 1942:211
Pima (AZ)	*N. rustica*	Cultivated	Castetter 1943: 322-323
Coahuilla (CA)	*N. attenuata*	Sprinkled over an acre	Barrows 1900:74-75
Tubatulabals (CA)	*N. bigelovii* *N. attenuata*	Pruned and weeded plants on sandy flats	Voegelin 1938: 36-38
S. Dieguenos (CA)	*N. attenuata*	Cultivated near houses on newly burned ground	Setchell 1921:411
Acoma, Isleta, Jemez, Picuris, Santo Domingo, Taos (NMEX)	*N. rustica*	Cultivated	Castetter 1943: 322
Cochiti (NMEX)	*N. rustica*	Grown in garden plots by people important in native ceremonial life	Lange 1968:96-97
Santa Ana (NMEX)	*N. rustica*	Cultivated	White 1941:64-65
Tewa (NMEX)	*N. attenuata*	Formerly cultivated	Robbins, *et al.* 1916:103
N. Paiute (various states)	*Nicotiana* spp.	12 of 14 bands burned prior to planting	Stewart 1941:376

TABLE 4.—*Select southwestern United States references to historic uses of wild tobacco. For an extensive survey of North American groups that have utilized wild tobacco, see Winter (1990).*

Group	Species	Notes	Reference(s)
Hopi (AZ)	*Nicotiana* spp.	"Cloud-tobacco" a mixture of wild tobacco, other plants, corn pollen, and minute yellow bird feathers	Stephen 1936: 172, 599
	N. attenuata	Harvested as "weeds" from garden of other crop(s)	White 1941:65
Pima (AZ)	*N. trigonophylla*, *N. attenuata*, *N. bigelovii*	Smoked; *N. trigonophylla* traded from Papago	Russell 1975:119
Yuma (AZ)	*N. trigonophylla*	Smoked	Goodspeed 1954: 386
Zuni (NMEX)	*N. attenuata*	Clan name	Stevenson 1915: 86
Washoe (NV)	*N. attenuata*	Smoked	Setchell 1921:411
S. Paiutes (various states)	*N. attenuata*	Leaves smoked	Bye 1972:95

to recent reports of its presence in prehistoric Hohokam contexts (as previously cited).

The similarity in stem transverse (cross) section between the contents of all 12 Red Bow cigarettes (Fig. 3) and modern *Nicotiana* plants is notable. When stems of equal diameter are compared, the relative proportion of pith to stem wall, the spacing and abundance of rays, and the general arrangement of xylem cells of both *N. attenuata* and *N. trigonophylla* correspond well. However, it is not known to what extent other herbaceous dicotyledons might have stem cross-sections that are confusingly similar.

Specimens #1 and #3 have preserved enough evidence of the alternate-branching pattern to suggest that a smaller side branch from a main stem arose in the axil of a long-petioled leaf. Such an arrangement is characteristic of *Nicotiana attenuata* and *N. rustica* which both display distinctly petioled leaves, at least near the base of their stems, as opposed to the sessile, almost clasping leaves of *N. trigonophylla* (Goodspeed 1954:352, 385, 429).

The presence of trichomes (hairs) of various types, studied in detail on worldwide *Nicotiana* by Goodspeed (1954:102–135), is considered a very useful character in attempts to specifically identify tobacco. At 200x magnification, the

contents of Red Bow cigarettes #1, #2, #3 and #9 have widely-spaced glandular trichomes ranging from 0.12–0.20 mm in length. Such trichomes, composed of short stalks topped with amber-colored glands of one–many cells, are characteristically found on modern *N. attenuata* stems (Goodspeed 1954:133). In contrast, the stems of *N. trigonophylla* are densely covered with longer (0.30–0.40 mm) trichomes, the majority of which are highly branched and lacking amber-colored glands (see also Goodspeed 1954:117, 133). The abundant trichomes on stems of *N. rustica* L. are glandless branched and simple hairs; they also seem a poor match to the four Red Bow specimens.

In sum, the contents of two cigarettes (#1 and #3) have (1) similar stem cross-sections, (2) the pattern of a side branch emerging from the axil of a long-petioled leaf, and (3) the diagnostic glandular trichomes characteristic of *Nicotiana attenuata*. Specimens from two additional cigarettes (#2 and #9) have also retained the glandular trichomes common to *N. attenuata*. Although the remaining 8 specimens lack hairs, possibly because of extensive insect damage, they do display the general stem cross-section appearance noted on all the *Nicotiana* species included in this study. This leaves open the possibility that the Red Bow inhabitants utilized multiple tobacco species, or possibly even other herbaceous dicotyledons, for cigarette filler material.

Future pursuits.—Identification of the contents of four Red Bow cigarettes as the broken stems of *Nicotiana attenuata* might be strengthened in two ways, both of them destructive in nature. Scanning Electron Microscope (SEM) preparations of stem epidermis (where remaining) and vascular tissue could be compared to similar preparations of modern *Nicotiana* material and to established descriptions (Goodspeed 1954:102–106). Also, the material could be tested chemically for nicotine or nicotinic acid, but these compounds may not remain stable over the long run (Dixon and Stetson 1922; Jones and Morris 1960).

SUMMARY

Archaeologists and botanists may well have been correct when writing that ancient groups placed "tobacco" (e.g. *Nicotiana)* inside reedgrass (e.g. *Phragmites)* cigarettes. Anatomical and morphological criteria of four uncharred cigarettes from Red Bow Cliff Dwelling in Arizona suggest this to have been the case. However, it might be unwise to assume that the cigarettes from other locations will reveal identical construction material, or the same filling components. Such a broadly distributed and well-preserved class of artifacts should be thoroughly evaluated to establish the cultural dimensions of ancient cigarette manufacture, and to determine the range of materials placed inside.

ACKNOWLEDGMENTS

I owe thanks to a number of individuals who contributed to this project. Dr. Emil Haury provided both the impetus for this look at ceremonial cigarettes and cleared the path for funding by the Agnese Lindley Foundation of Tucson. Two noted Southwestern grass experts, Dr. John R. and Charlotte G. Reeder, pointed me in the direction of pertinent

literature on Gramineae. Louise M. Rogers sketched a draft of the figures, and Ron Beckwith produced the final drawings included in this report. Both Joseph C. Winter and Robert Gasser offered very helpful comments that improved the clarity of the paper. Rex K. Adams kindly assisted in the examination of the material. As I served as photographer, both Rex and Adrian J. Rogers made reedgrass cigarettes and smoked them stuffed with pine needles, to simulate a North American traditional practice. This attempt to gain first-hand insight into a Southwestern cultural experience nearly severed two long and rewarding friendships; it has become clear that next time it will be *my* turn to smoke.

NOTES

[1]*Phragmites australis* (Cav.) Trin. ex Steudel. is considered to have priority over *Phragmites communis* Trin. (Clayton 1968).

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BOOK REVIEW

The Food of China. E.N. Anderson. New Haven and London: Yale University Press. 1990. Pp. xv, 313. $23.50 hardcover. ISBN:0–300–03655–7. (Also available in paperback.)

To call this book simply "The Food of China" is a modest understatement of its broad scope and the wealth of information it contains. Easy to read and extremely entertaining, the book will be enjoyed by anyone with a fascination for history, anthropology, archaeology, language, nutrition, medicine, politics, human ecology, and/or literature. Any ethnobiologist will find it completely engrossing.

Many stories are interwoven: the origins of agriculture, the development of different styles of agriculture based on ecological and historical factors, the origins of different cooking techniques, regional variations in foods and beverages, the introduction and adoption of foods from different parts of the world, the influences on food and food production of various rulers and officials, the effects of dynastic conflicts, wars and other such events, as well as a review of the pertinent literature, both ancient and modern.

The book is organized into twelve chapters. The first provides background information on the geography, climate and vegetation of China. Chapters two to seven comprise a chronological account of the foods of China, with indepth discussions of early peoples in China, the origins of agriculture, development of cultivation and food preparation techniques, and the effects of political events on food. Chapter eight describes in vivid detail the foods and beverages of modern Chinese cuisine—soybeans, peppers, mustard greens, sweet potatoes, squash and melons, tree fruits, tea, fish, shellfish, and other aquatic animal foods, poultry, pork, mutton, and water buffalo, to name just a few. Chapter nine describes basic cooking strategies, with descriptions of vessels, utensils and cooking methods. Chapter ten is devoted to regional differences in foods and food preparation. Chapter eleven discusses the close and inseparable linkage between food and medicine in Chinese culture. Finally, Chapter twelve rounds out the book with a discussion of the social aspects of food and recent influences on Chinese cuisine.

Every page is crammed with fascinating details relating to food, history and culture. On page 77, for example, is the story of the introduction in 1011, during the Sung Dynasty, of a new short-growing-season, drought-resistant rice from Champa and a new heavy-yielding variety of Indian green lentil (possibly the green mung bean). Emperor Chang-tsung dispatched envoys to secure these

varieties, which were immediately planted. When the first harvests were reaped the Emperor called his top ministers to taste them and composed poems in praise of these new wonder crops. The Champa rice was highly significant because it allowed a vast increase in double-cropping, which became a common practice in southeastern China.

On page 160, we learn that tomatoes were introduced to China from the West in the 1500s and were promptly named *fan chieh* ("barbarian eggplant"). Also, the name, *k'e tsap,* meaning "tomato sauce" in Cantonese, is not the original term from which English "ketchup" or "catsup" was derived; the latter terms are cognate with French *escaveche* and Spanish *escabeche,* meaning "food in sauce."

On page 252, Anderson discusses the use of monosodium glutamate (MSG), now widely associated with Chinese cooking. In fact, it is a relatively recent addition, originating from a Japanese seaweed preparation marketed just after the turn of the century. In Anderson's opinion, its introduction was an unfortunate one, since it is allergenic to many people, and "adds a heavy, harsh, metallic taste to Chinese food and wrecks the subtle and complex blending of flavors essential to fine cuisine ..." Any page, turned to at random, yields such intriguing morsels of information.

This authoritative yet thoroughly readable book is enhanced by a fine, detailed index. The only improvement, in my opinion, would be the addition of illustrations, modern and historical, to enable the reader to visualize more easily the topics under discussion.

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A PERSPECTIVE ON MEXICAN ETHNOBOTANY

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ABSTRACT.—The following commentary represents a personal view of some aspects of ethnobotanical research in Mexico that may help to better understand its present orientation. In addition, C. Earle Smith Jr.'s contribution to Mexican ethnobotany is considered. The current focus of Mexican ethnobotanical research is seen as the result of increasing politization and developing social consciousness among investigators, and is largely directed towards applied research which seeks to directly benefit needy sectors of society as well as the scientific community.

RESUMEN.—Este comentario representa un punto de vista personal hacía algunos aspectos de la investigación etnobotánica en México, lo cual permite una mayor comprensión de su orientación. Además, se considera la contribución de C. Earle Smith, Jr. a la etnobotanica mexicana. El enfoque actual de la etnobotánica en México esta visto como una consecuencia del aumento en la politizacion y el desarrollo de mayor conciencia social por parte de los investigadores, y dirigidas hacía la investigación aplicada, la cual, a su vez, propone beneficiar a los sectores más necesitados de la sociedad además de la comunidad científica.

RESUME.—Ce commentaire représent un point de vue personnel sur quelques aspects de la recherche ethnobotanique au Mexique, ce qui permet une compréhension de sa orientation. En plus, on adresse la contribution de C. Earle Smith, Jr. a l'ethnobotanique mexicaine. On voit la mise au point de la recherche ethnobotanique mexicaine comme un effet de l'accroissement de la politisation et le dévelopement d'une conscience sociale en augmentation de la part des chercheurs. Elle est dirigée vers la recherche appliquée, que propose améliorer les secteurs les plus manguant de la société, en dehors de la communauté scientifique.

INTRODUCTION

The goals of ethnobotanical research vary in different national contexts, and investigators are not always aware of the circumstances that have contributed toward the development of this discipline in other countries. The following commentary represents a personal view of some aspects of Mexican ethnobotany that may help to place its present focus in a broader perspective. In keeping with the dedication of this number of the *Journal of Ethnobiology* to the memory of C. Earle Smith, Jr., his contribution to the development of Mexican ethnobotany is considered. Although his participation was largely indirect, in collaboration with projects sponsored by North American institutions and in training some of the paleoethnobotanists currently doing research, his work represents an important component of ethnobotanical research in Mexico.

It is beyond the scope of these comments to present a historically oriented summary of the development of ethnobotany since its initial definition at the close of the 19th century (Harshberger 1896) through the first half of the 20th century (Castetter 1944; Jones 1941; Maldonado–Koerdell 1940; Schultes 1941), when basic concepts and directions for research were established. A detailed treatment of this time period is provided by Ford (1978).

In spite of the recognized importance of some of the ecological aspects of the interaction between human groups and vegetation (Kroeber 1939), it was during the 1960s, at the height of the impact of cultural ecology in North American anthropology, that a concern for the relationships between man and plants became evident. Three areas of anthropologically–oriented ethnobotanical research grew rapidly during this period: paleoethnobotany (recovery, identification and interpretation of archaeological plant remains); ethnoscience (the study of indigenous taxonomic nomenclature with a goal toward elucidation of the cognitive principles of classification); and ecological anthropology (including ethnographic studies which explored the relationships among human populations and their exploitation of the natural environment). From a botanical point of view, these approaches all share certain methodological characteristics insofar as the collection of data is concerned, but differ with respect to the interpretation of accumulated information. For the most part, ethnobotanical studies during the 1960s and 1970s were largely synthetic, descriptive summaries of the data obtained from field studies.

ETHNOBOTANY IN MEXICO

Although it was during the 20th century when the term "ethnobotany" came to be applied to a specific field of research, the study of plant use is deeply rooted in tradition, as indicated by 16th century and later Colonial period descriptions of plant use and the beliefs which surrounded them. The best known examples are the works of Sahagún (Florentine Codex: Dibble and Anderson 1963; Estrada L. *et al.* 1988), Martín de la Cruz (Badianus Manuscript: Emmart 1940; De La Cruz 1964; see also Miranda and Valdés 1964) and Francisco Hernández (1943, 1959; see also Valdés and Flores 1985).

There continues to be some confusion over the distinction between ethnobotany and economic botany, in theory and practice (see Gómez–Pompa 1982, 1986), and it might be argued that the only clear difference between them in Mexican research is in the application of results and not in the research techniques employed. Certainly ethnobotany places a greater emphasis on the role of plants in a society, including attitudes and ideology that surround them as well as their uses, whereas economic botany tends more toward documenting uses and potential applications.

It should be mentioned that the majority of Mexican ethnobotanists have been trained as biologists rather than anthropologists. In general, most of the ethnobotanical studies carried out in Mexico before 1970 were descriptive in nature. Botanical as well as anthropological literature up until that point generally lacks any discussion concerning the definition and application of specific concepts of ethnobotany. One exception is Maldonado–Koerdell (1940), who explicitly

stressed the need for ethnobiological studies which go beyond the classification of data in terms of western botanical or zoological nomenclature, to study biological elements as a function of the human group and associated cultural complex of which they are a part. However, he himself expressed the opinion that ethnobiology was of an essentially synthetic character. Other notable exceptions include the analyses and interpretations of ethnohistorical documents of Martín del Campo (1938, 1940, 1941) and the ethnographic observations of Hernández X. (1985, 1987) during the 1940s, 1950s and early 1960s.

The publication of *Exploración Etnobotánica y su Metodología* by Hernández X. (1970) marked the beginning of the decade during which ethnobotany in Mexico experienced its strongest development. While the relatively brief text contributes nothing new to the definition of ethnobotany (which is, in fact, relegated to a short footnote), the concept is strikingly different from previous descriptions of indigenous or mestizo plant use. Through a series of anecdotes based on field experiences in diverse areas of Latin America, it is possible for the reader to be both observer and participant. The third world farmer is portrayed in a completely different light than in many earlier studies and is shown to be far more sophisticated in knowledge and experience and far more observant of nature than the administrators and scientific advisors of the farming systems of industrialized nations.

In chronological terms, the growth of ethnobotany seems to coincide with the impact of ethnoscience and the approach to ethnobiology implicit in that area of anthropological inquiry. However, the ethnoscientific approach never achieved great popularity among Mexican investigators. The impact of human ecology and, to some extent, cultural ecology, is much more evident. Numerous published works appeared in which theoretical, ideological issues as well as ethnobotanical research results were reported (Bárcenas *et al.* 1982; Díaz 1976a, 1976b; Lozoya 1976; Viesca 1976, 1977, 1978; Barrera M., Barrera V. and López 1976, among others).

An increasing politization of practitioners in some areas of scientific research in Mexico, including ethnobotany, developed during the 1970s in response to what were perceived as diverse forms of repression prevalent at different levels of Mexican society. The subsequent reaction of many academics, including students and faculty, took the form of a radical reorientation in their concept of academic priorities. The political and social developments of the decade that affected academic spheres have been recently described by Toledo (n.d.; see also 1982).

Recent trends in Mexican ethnoboany can be viewed partially as a response to the obvious incongruities visible at all levels of society. Many investigators have contributed to the changing direction of ethnobotanical inquiry, toward the search for appropriate contexts within which scientific skill can be combined with socio-political consciousness: the goal being to design and carry out research that can return direct benefits to the sectors of society that share their knowledge and experience with the researcher, who, in turn, contributes it to science.

During the 1970s, "immersion" in the indigenous system was seen as a way in which an ethnobotanist could study traditional knowledge in its own cultural and historical context. Immersion refers here to extensive as well as intensive field

work in the community or region to be studied, incorporating what could essentially be described as an ethnographic approach to data collection through long-term residence. At the same time, it implies an *emic* approach to the study which transcends the observation of biological phenomena, to include relevant aspects of social organization, socio-economic and political variables, belief systems and the articulation of the local population with national level society, among others. Finally, it was felt that this approach to biological field work would provide insight into the needs of the community under study and thus facilitate the researcher's goals of reverting the products of his experience into the indigenous community (Toledo 1982). The ideal would be to develop indigenous consciousness and appreciation of their own values through educational programs which would stress the positive elements of their ethnobotanical and other traditions. At a less ambitious but no less ideal level, it has been argued that the recovery of traditonal values among indigenous groups would aid them in their struggle for survival against the thrust of national society and the homogenizing process of Mexicanization.

At present, Mexican ethnobotany seems to be taking a somewhat more orthodox approach than in the 1970s to further its ends, insofar as methodology and the use of advanced technology is concerned. However, a different concept of ethnobotany motivates this research. Although the perceptions of what constitutes ethnobotany continue to reflect the concerns of particular research problems, the general concept is that of scientific activity which permits the acquisition and application of knowledge relevant to clearly defined problems which affect the most needy sectors of the population. To name a few: the development of nutritious and productive food plants based on the broad distribution of highly adaptive indigenous wild species; the recovery of traditional resource management techniques of varying scale, which can be introduced or re-introduced into areas where ecological deterioration has resulted from the application of short term intensification; the development of medicines and medical treatments based on indigenous techniques popularly recognized as superior to "modern" cures, and within the economic means of needy sectors of society.

In the political sphere, success has been limited and slow. Scientific development is a victim of administration, and has never been one of the national government's outstanding priorities. However, a maturation process, political as well as intellectual, is visible as increasingly more interdisciplinary research projects incorporate the diffusion of results at a popular level, with the hope of benefits that can affect the long-term improvement of living conditions of large sectors of the population.

Thus, the concept of contemporary ethnobotany in Mexico involves a deep commitment: to mobilize all of one's scientific and humanistic capacity toward the resolution of real problems that affect the population. Definitions will vary and the knowledge obtained will undoubtedly continue to reflect the researcher's theoretical and methodological orientation. The application of ethnobotanical knowledge, however, will depend upon the socio-economic level of the population, acculturation processes of the population in general, and the interests of the researcher himself.

C. EARLE SMITH, JR.: CONTRIBUTIONS TO MEXICAN ETHNOBOTANY

Ethnobotany has undergone intense development during the past two decades. Similarly, its subdiscipline paleoethnobotany has become increasingly important. Not only are theoretical and quantitative concerns in the forefront, but also technological advances which expedite certain aspects of research, as well as its applications.

The research of C. Earle Smith, Jr. (Smitty) represents a significant contribution to Mexican ethnobotany. He was on familiar terms with a number of Mexican colleagues, although he apparently did not collaborate with them formally. Several paleoethnobotanists currently working in Mexico have worked with him at some stage in their training, and all have relied on his pioneering research in Mesoamerican archaeobotany. His studies of agricultural systems and traditional plant use are equally significant although lesser known. The importance of particular plant resources in the distant pre-hispanic past, the independent development of domesticated plants which form the basis of the traditional diet today, and the dimensions of prehistoric agricultural systems owe much of their recognition to his research. Needless to say, the majority of Mexican ethnobotanists are familiar with his published reports, particularly in relation to the archaeobotanical remains from the Tehuacan Valley. Time and again, his work is cited verbally or in print, although the published citations often refer to the editor of the volume in which his research appeared.

As an ethnobotanist often associated with some sort of "old school," Smitty had little time or interest in the development of armchair theory. An incessantly active individual, he took advantage of every opportunity to be in the field. His experience was, on the one hand, broad; and on the other, profound. Many of the published reports of his ethnobotanical as well as paleoethnobotanical research reveal this characteristic, although some readers are slow to grasp it. Some might criticize the apparent lack of detail in many of his descriptions, or the absence of quantitative analysis in most of them. I think these superficial shortcomings are the product of an impatience with the written word, an inadequate medium for the communication of ideas. At the same time, many of his brief statements carry a tightly-packed load of information.

On a more personal note, Smitty's most effective means of communication was verbal—in the classroom or laboratory, in the field, or over a quiet brown-bag lunch in his office. Interspersed with anecdotes collected over decades of study and travel, academic and otherwise, conversations touched on the most substantive theoretical issues in botany, ethnobotany, paleoethnobotany and ecology, among others. He possessed an innate desire to constantly increase his knowledge, and was privileged to possess a keen mind which assimilated immense quantities of information. I suspect that generations of students are able to recall these and other qualities which contributed to Smitty's charisma. His recognition of his own limitations is manifest in his intense training of students and encouragement of their use of new techniques for the recovery and analysis of ethnobotanical and paleoethnobotanical data, even though he himself did not consider more

sophisticated descriptive techniques to be as important as recovery and identification.

Though few Mexican researchers are aware of it, Smitty's orientation was totally congruent with the direction that ethnobotany has taken in Mexico. For example, a paper published in Mexico in 1978 reflects his awareness of the limitations of ethnobotanical studies which fail to consider social, economic and biological variables of the human populations which use the plants being studied.

CONCLUSION

Ethnobotany and its related areas of research make unusual demands upon scientists, partly because of its interdisciplinary character and, also, because of its link with social sciences and the personal commitment to society that research in the social sciences can and should imply. The degree of personal commitment in ethnobotanical research varies greatly among individuals and is manifest in the realm of individual conscience. The degree to which ethnobotany has developed in Mexico may not be representative of Latin America in general, but it is an appropriate response in its own context.

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BOOK REVIEW

Semelai Culture and Resin Technology. Rosemary Gianno. New Haven, CT: Connecticut Academy of Arts and Sciences, 1990. 238 pp. $40.00 (cloth).

This big, beautiful book is, I think, destined to become a classic of its kind. Gianno has managed to integrate technical expertise from several fields into a clear and unpretentious analytical exposition of a hitherto neglected mode of exploiting tropical rainforest. The book is thus important both because its ethnographic focus is novel and because its analytical sophistication is exemplary.

The problem which initially engages Gianno's attention is that, although people almost universally use resins, prehistorians often cannot identify them and, in the absence of ethnographic data, would be unable to make many inferences about patterns of trade and production even if they could. This ignorance is particularly debilitating to tropical archaeology, since tropical resins survive better in archaeological sites than those from temperate zones, which (except for amber) are mostly pine resins and therefore come in smaller bits and do not polymerize. Gianno's solution is first to present a number of ways to identify and characterize resins, including both vernacular and technical English vocabularies, as well as chemical and spectrometric analyses. Partly because of her ethnoscientific skills and partly because she writes clearly, she makes attentive readers comfortable with kinos, triterpenoids, limnetic variables, Fourier transforms infrared spectrometry and other arcana not usually part of an anthropologist's vocabulary or conceptual apparatus. Throughout the book she defines each term likely to be unfamiliar as it arises.

The rest of the text concerns a particular mode of producing and trading resins, in its cultural context. The people involved are Semelai, Aslian (Austroasiatic)-speaking people of west Malaysia who have been extensively involved in producing and trading resins for centuries, at least. This section includes a meticulous ethnoscientific study coupled with descriptive accounts of the many Semelai techniques. These descriptions are careful enough that, after reading them, readers should be able to identify and collect resins themselves. The apparently effortless integration of qualitative and quantitative data is impressive.

The text proper is less than 150 pages long. Five wonderful appendices make up about 50 pages more. The rest comprises maps, plates and an index. The only annoyance is the fault of the printer rather than the author. The table of contents lists the maps and plates at the end of the book, although they appear at the beginning. Not all the species mentioned in the text occur in appendices listing species mentioned in the text. A palm is *Livistona kingiana* on p. 134 in the text but *L. kingii* on p. 201 of the appendices. The printer supplies readers with a sticker to amend the misinformation on the copyright page. It is a shame to mar so opulent a production of so fine a study this way. It would also be useful to have a longer index for readers interested in matters outside the main emphasis of the book.

My few niggling complaints about the text itself have to do with cross-cultural connections, especially etymologies, which Gianno as an ethnoscientist alludes to but does not consistently follow up. For example (p. 41), *papaq* comes from

a Malay word meaning "confused;" in some dialects of Semai, another Aslian language, it refers to "sexual insanity" and a cognate of *ktet* refers to vaginal prolapse, all germane to the context Gianno is discussing. She puzzles over the word *riway* in a list of words derived from Malay and referring to aspects of the psyche, although cognates of *riway* in other Aslian languages also refer to "souls." Although the names of the characters in the Semelai dema myth (pp. 46–47) are Islamic, dema myths are common throughout Southeast Asia and adjacent Melanesia and are almost certainly preIslamic. The wise–fool character Paner (e.g. 132–133) also occurs among Btsisi', another south Aslian people. As Pak [P]andir (Malay "Dummy"), he also appears in textbooks read by Semelai and Btsisi' children. This sort of comparison, however, really lies outside the tight focus of Gianno's book, and omitting it does not seriously affect her interpretation.

Similarly, the suggestion in chapter 3 ("Semelai ecology, culture, and society") that Semelai kinship might be "derived from" a Malay one (p. 39) may puzzle readers unfamiliar with Benjamin's structuralist analysis of west Malaysian kinship systems as variations on a theme. While this analysis is an interesting intellectual exercise that clarifies similarities and differences among coexisting systems which have affected each other, it lacks historicity or explanatory value. As is common in contact situations, much of the Semelai vocabulary of kinship is of Malay origin but the underlying structures seems to remain distinctively Aslian; pidgin languages form the same way. Not only are core Semelai terms clearly Aslian but the terminological system as a whole involves an unusual bifurcation by relative age, analogous to the bifurcation by relative sex in some "Iroquois" systems, a dimension found among other Aslians but not, as far as I know, among Malays, who are Austronesian speakers. Gianno recognizes this dimension but dismisses it, without explanation, as "minor." Another "unusual feature" (p. 41) is the "collapse" of children and parents into a single generation, which Gianno suggests must be "quite recent." It was reported among Btsisi', another South Aslian people, thirty years ago; again, it is a structural feature found among Aslians but not, as far as I know, among Austronesians. In short, Semelai kinship structure seems distinct in origin from its Austronesian counterpart, though the systems are tending to converge as political and economic pressures bring Semelai into the Malaysian mainstream.

Especially in chapters 5 and 8 Gianno examines whether traditional Semelai methods of exploiting rainforest are viable in modern Malaysia, raising the question of Semelai attachment to their current swampy lands. Malaysian law, like the British law from which these provisions derive, does not recognize Aslian land rights. Tradition and the scanty archaeological evidence suggest a hiatus in occupation around 1700 AD, due, Semelai say, to a great flood. Intensive slave raids by Minangkabau and Mendiling, outlawed in 1915 but continuing for several years thereafter, may have pushed Semelai back into the swamps. British resettlement policy during the Communist insurgency of the 1950s again displaced the people. Current government policy, which involves replacing rainforest with commercial plantations, is again disrupting whatever "normalcy" may mean to Semelai, who are themselves resigned to the destruction of their forest resources. Under the circumstances, the persistence of Semelai as a people is remarkable. It is less remarkable that, like their neighbors, the foraging Batek, they can

demonstrate no long term attachment to their land. One interpretation of ancient Malay tradition (adat), derived from ancient Sanskrit and Muslim law, would involve special treatment for Semelai as "ancient inhabitants" of their territory anyway; but the pressures of development and the weight of history make such an interpretation unlikely. The short answer to the question of viability therefore is "no."

Still, Gianno argues that tapping is an extremely efficient use of the forest, even more sustainable than controlled lumbering or farming. Lumbering not only destroys part of the forest but stimulates Semelai to "harvest" trees, e.g. for eaglewood, to "get as much wood as they can before the forest is eradicated" (pp. 97, 140). The availability of chainsaws makes this harvesting easy. By contrast, says Gianno, tapping is less labor- and captial-intensive than lumbering or intensive agriculture. Moreover, she argues, given the fluctuating markets and erratic demand for tropical products, depending on a diverse tropical forest is safer than depending on monocropping.

I suspect, however, that people in charge of development in Malaysia or anywhere else in the world are unlikely to read this book or to be influenced by its arguments. I know of no country whose politicians readily change course because of academic treatises. Anthropologists and ecologists, however, will find it an invaluable reference which sets high standards for future research.

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MEXICAN MARKET PLANTS OF 16th CENTURY. I. PLANTS RECORDED IN *HISTORIA NATURAL DE NUEVA ESPAÑA.*

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ABSTRACT.—Four vegetal products and one ecological associate are registered by Francisco Hernández from the central Mexican markets during the period 1571 and 1576. The commercially important plants were "cacahoaquáhuitl" ("cacao," *Theobroma cacao),* "texócotl" ("tejocote," *Crataegus pubescens),* "xochinacaztli" ("flor de oreja," *Cymbopetalum penduliflorum),* and "nantzinxócotl" ("nanche," *Byrsonima crassifolia)* while the market floor was carpeted by "tianquizpepetla" *(Guilleminea densa* and *Alternanthera repens).* Although names and certain uses for each plant are comparable in both the 16th and the 20th centuries, the continuity between these periods is limited to the edible seeds of "cacao" and edible fruits of "tejocote." Two tropical products (aromatic flowers of "flor de oreja" and medicinal bark of "nanche") derived from the former Aztec Empire periphery disappeared entirely from the Mexico City markets between the 17th and 19th centuries. The increase in the number of named fruit forms of "nanche" and "tejocote" may be due to an intensification of their domestication since the colonial period.

RESUMEN.—Productos de cuatro plantas y una planta ecologicamente asociada son registrados por Francisco Hernández para los mercados del México central, entre el período 1571 y 1576. Las plantas comercialmente importantes fueron "cacahoaquáhuitl" ("cacao," *Theobroma cacao),* "texócotl" ("tejocote," *Crataegus pubescens),* "xochinacaztli" ("flor de oreja," *Cymbopetalum penduliflorum),* y "nantzinxócotl" ("nanche," *Byrsonima crassifolia),* mientras que los suelos del mercado estaban tapizados por "tianquizpepetla" *(Guilleminea densa* y *Alternanthera repens).* Aunque los nombres y ciertos usos para cada planta son comparables en ambos siglos el XVI y el XX, la continuidad entre esos períodos está limitada a las semillas comestibles de "cacao" y a los frutos de "tejocote." Dos productos tropicales (las flores aromáticas de "flor de oreja" y la corteza medicinal de "nanche") procedentes de la periferia del imperio azteca desaparecieron por completo de los mercados de la Ciudad de México entre los siglos XVII y XIX. Se incrementaron las clases nombradas de frutos de "nanche" y "tejocote," lo cual se pudo deber a la intensificación de su domesticación desde el período colonial.

RESUME.—Quatre produits végétaux et une plante ecologiquement associée sont compris dans le registre des marchés mexicains pendant la periode 1571–1576. Les plantes d'importance commerciale étaient "cacahoaquahuitl" ("cacao," *Theobroma cacao),* "texocotl" ("tejocote," *Cratagus pubescens),* "xochinacaztle" ("fleur d'oreille," *Cymbotepalum penduliflor),* et "nantzinxocotl ("nanche," *Byrsonima crassifolia),* pendant que le plancher du marché s'est couvri pour "tianquizpepetla" *(Guilleminea densa* et *Alternathera repens).* Bien que les noms et

certains des usages de chaque plante sont comparables dans le 16–iéme et le 20–iéme siécle la continuité entre ces deux époques s'est limité aux semences comestibles du ''cacao'' et aux fruits comestibles du ''tejocote.'' Deux produits tropicaux (les fleurs aromatiques de la ''fleur d'oreille'' et l'écorce medicinale du ''nanche''), qui sont derivés de la region périphérique de l'empire aztéque, sont disaparus des marchés de Mexico entre le 17–iéme et le 19–iéme siécles. On peut expliquer l'augmentation chez le numéro des formes nommés des fruits du ''nanche'' et du ''tejocote'' pour l'intensification dans sa domestication aprés l'époque coloniale.

INTRODUCTION

Since the economic institutions of a society are deeply embedded within the social fabric of their respective cultures, archaeologists and historians have found source analysis and resource movement to be useful. The study of the flow and direction of materials allows the spatial modeling of economic activity and the reconstruction of social interactions. Ethnobiology promises to benefit from using a similar analysis of biological remains and their associated artifacts and historical references.

The market system (''tianquiztli'' in Nahuatl) of the Aztec Empire was a highly developed social, political and economic system with an intergrated exchange mechanism among diverse ethnic groups and across different ecological zones. According to Hernán Cortés (1981), Bernal Díaz del Castillo (1977), Diego Durán (1971) and Bernardino de Sahagún (1979), the first Spaniards arriving in Mexico marvelled at the richness, size, complexity, and smooth operation of the Triple Alliance's markets such as that at Tlatelolco, near Tenochtitlan.

These markets were one of the chief traits of Mesoamerican societies (Kirchhoff 1943) and dated back more than 20 centuries (Hirth 1984). During the Formative Period (1500 BC–AD 150), the market as well as other methods such as reciprocity, redistribution, and patron–client lineages developed for exchanging goods (e.g., ceramic, obsidian and shell material and products) (Sanders 1984). Later, when marketplace trade enjoyed considerable growth, the socioeconomic and political structures became more complex. In response to this expansion, two classes of merchants evolved—the ''tlamacani'' who were dedicated to local resale and the ''pochteca'' who practiced long distance trade (Acosta 1945). The integration of the regional markets gave a certain degree of coherence to the conquest-state. During the early Postclassic Period (AD 950–1150), the long–distance trade by the peoples of the Basin of Mexico exploded as the Classic Period Mayan, Teotihuacan and Monte Alban states collapsed and the network of the elite societies intensified (Smith 1986).

With the disintegration of other Mesoamerican cultural centers, that of the Basin of Mexico dominated because it had a larger and denser population than surrounding areas and also had more intense processes of political interaction and competition (Smith 1986). In 1429, the Triple Alliance was formed by the Mexica, Acolhua and Tepanec polities and ruled most of Mesoamerica from Tenochtitlan. After 1438, however, their integration mechanisms, similar to those used by earlier conquest–states, were not as effective in binding the provinces

outside of the Basin of Mexico to the Triple Alliance. This deterioration was caused by increased distances and physiographic obstacles to communication between the conquered peoples and the imperial capital, by tenacious ethnic affiliation, and by persistence of strong regional marketing (Smith 1986).

As "one of the most impressive survivals of ancient Mexico" (Peterson 1959:217), the markets provide fertile ground for ethnobotanical investigation. Contemporary ethnobotanical studies of market plants reveal spatial and temporal partitioning, patterns of flow, ecological variables and evolutionary changes (Bye and Linares 1983). An examination of historical documents should reveal similar phenomena if we assume that contemporary markets of central Mexico have persisted since prehispanic times. However, until the elements of ancient and modern markets can be shown to represent either continuity or disjunction, we advise caution in the interpretation of past and present patterns which appear to be the same. Studies in Mesoamerican art (Kubler 1961) and religion (van der Loo 1987) using thematic units have demonstrated certain continuities in which these units have survived over time in the same cultural contexts as well as certain disjunctions in which particular elements of different time periods are similar but are found in different frameworks.

In an attempt to construct an information base from which to project future ethnobotanical inquiries grounded in source analysis and resource flow and to determine the continuity or disjunction of the biological products of plant–human interactions over time, we analyze the information about market plants of 16th century found in early post–Conquest documents in comparison with that of the 20th century. Because we assume that the descriptions of the markets by the Spanish chroniclers of the 1500s are applicable to the pre–Conquest "tianguis," no distinction is made between the Aztec and the early colonial markets of central Mexico. This report is the first in a series that will focus on plants mentioned by the early colonial authors as being specifically associated with the markets. This approach contrasts with an earlier method in which we examined contemporary market plants that were cited in historical publications (Bye and Linares 1987). The work of Francisco Hernández, *Historia Natural de Nueva España,* initiates our series.

THE WORK OF FRANCISCO HERNANDEZ

Francisco Hernández wrote the *Historia Natural de Nueva España* based upon his field observations in Mexico starting in 1571, 50 years after the Conquest. For five years, he served as Spanish King Phillip the Second's medical doctor in the New World and was charged with documenting the indigenous remedies. Although his original documents are lost, two early editions are known (Flores and Valdés 1979). The "Thesaurus" or Roman edition was published in 1651 with Latin text and illustrations. In 1790, the Madrid edition known as the "Matritense" appeared with Latin text and few illustrations. During the 20th century, two more editions appeared but with Spanish texts. Between 1942 and 1946, the Institute of Biology of the National Autonomous University of Mexico (UNAM) printed an incomplete version with only seven of the existing 24 botanical books. Later, all the natural history books plus other works of Hernández as well as contem-

porary analyses of his contribution were published by the Hernández Commission of UNAM starting in 1959. Volumes II and III of the Obras Completas (Hernández 1959) include the *Historia Natural de las Plantas de Nueva España* and are based upon translations from both the Roman and Madrid editions.

Valdés and Flores (1985) have summarized the botanical analyses of the plants described in Hernández (1959). Of the 3076 plants discussed in his work, 1544 have been studied by various authors. Of these, 98 have been identified to family, 249 to genus and 667 to species. It was not possible to identify the remaining 530 plants. The geographic distributions are given for 1858 plants and reflect his travels in the Valley of Mexico as well as in the modern states of Guanajuato, Hidalgo, Mexico, Michoacan, Morelos, Oaxaca, Puebla, Queretaro, and Tlaxcala. Nahuatl names are given for 3000 plants while fewer than 300 plants have Purepechan, Huastecan, Antillian, Peruvian and Philipian names. Other data include morphological descriptions, habitat information, uses and hot–cold qualities of the plants.

METHODS

We used the analytical index of the UNAM edition (Hernández 1959: III: 419–524) to select the plants that Hernández associated with markets or "tianguis." This search yielded five plants. In order to compensate for possibly incomplete indexing, we generated a list of associated plants that were reportedly used in combination with each of the five main plants. The plants in this list were subsequently located in other chapters so that we could determine if other market references occurred. No additional market plants were found.

In order to determine the botanical identity of each market plant, we then: (1) consulted previous suggested identifications (Valdés and Flores 1985); (2) analyzed the morphological and ecological characteristics mentioned in Hernández' text; (3) examined the diagnostic features of the accompanying illustrations (Figs. 1–4); and (4) compared the characteristics of Hernández' plants with those of contemporary plants sharing similar common names (Martínez 1979a). The Nahuatl names were analyzed using Santamaría (1978) and Siméon (1984).

Once the scientific names were determined, we compared the uses and qualities of each historic plant with those of plants in modern Mexican markets (principally the Mercado Sonora in Mexico City; Bye and Linares 1983; Linares *et al.* 1988), in the field and in ethnobotanical literature. Voucher specimens are deposited in the Ethnobotanical Collection of the Herbario Nacional (MEXU). Published data and specimens deposited in UNAM's Herbario Nacional (MEXU) were used to map the geographic distributions.

RESULTS

Hernández (1959) reported five plants from the 16th century Mexican markets. Four taxa were commercial elements and included "cacahoaquáhuitl," "nantzinxócotl," "texócotl," and "xochinacaztli." The fifth plant, "tianquizpepetla," was ecologically associated with the markets based upon the derivation of its common name.

CACAHOAQUÁHUITL 1

QUAUHPATLACHTLI 2

XOCHINACAZTLI 3

TIANQUIZPEPETLA 4

FIG. 1.—"Cacahoaquáhuitl" or *Theobroma cacao* from Hernández (1959: II:303).

FIG. 2.—"Quauhpatlachtli" or *Theobroma bicolor* from Hernández (1959: II:304).

FIG. 3.—"Xochinacaztli" or *Cymbopetalum penduliflorum* from Hernández (1959: III:68).

FIG. 4.—"Tianquizpeptla" or *Guilleminea densa* and/or *Alternanthera repens* from Hernández (1959: III:144).

''*Cacahoaquâhuitl*''—This name is derived from 'cacahuatl' = cacao and 'quauitl' = tree and was called ''árbol del cacao.'' It is *Theobroma cacao* L. (Valdés and Flores 1985) although two native species, *T. angustifolium* DC. and *T. bicolor* Humb. & Bonpl., are also known as ''cacao'' (Standley 1920–1926). Hernández (1959: II:303–305) commented that this tree (Fig. 1) was cultivated in the shade of ''atlinan'' (probably *Licania arborea* Seem.) in the hot regions of New Spain and had four recognized forms, listed in order by decreasing size of the fruits: ''quauhcacáhoatl,'' ''mecacacáhoatl,'' ''xochicacáhoatl,'' and ''tlalcacáhoatl.'' All produced seeds, ''cacáhoatl,'' which were used as money and to produce a beverage, although the seeds of the last variety were not used much as coins because of the small size. ''Quauhpatlachtli'' (Fig. 2) is probably *T. bicolor.* It was considered a close relative of ''cacahoaquâhuitl'' and produced sweeter seeds which were eaten toasted like almonds or less frequently prepared in a beverage.

The drink based upon only the seeds of ''cacahoaquâhuitl'' was given to the ill in order to alleviate fever and pain and for liver ailments. To treat dysentary, four ''cacao'' seeds toasted with an ounce of the gum ''holli'' (unidentified, probably a natural rubber which is known as ''hule'' in Spanish) were eaten.

The ''cacao'' beverages, originally reserved for the Aztec nobility, were diverse and were adopted by the Spanish. Hernández (1959: III:305) warned that excessive drinking of ''cacao'' would cause intestinal obstruction, changes in one's color as well as ''caquexia'' (possibly ''cachexia,'' a wasting disease; M. Kay, pers. comm.)[1] and other incurable illnesses. In addition to the simple drink in which the ''cacao'' seeds were the sole ingredients, four compound beverages were reported. ''Atextli'' ('watery paste') was a mixture of the finely ground, raw or toasted ''cacao'' seed with an equal amount of ''grano indio'' (unidentified). ''Mecaxóchitl'' *(Piper* sp.), ''xochinacaztli'' *(Cympotetalum penduliflorum* (Dunal) Baill.) and ''tlilxóchitl'' *(Vanilla planifolia* Andr.) were pulverized and added to this paste. Then the mixture was blended with water by pouring it back and forth in vessels until a foam was formed on top. The refreshing and nutritious drink was said to stimulate the appetite. Another preparation combined the seeds of ''cacahoapatlachtli'' *(T. bicolor)* with those of *T. cacao* and ''grano indio.'' A third drink called ''chocóllatl'' consisted of equal amounts of crushed seeds of ''cacao'' and ''póchotl'' *(Ceiba aesculifolia* (HBK.) Britt. & Bak. and *C. pentandra* (L.) Gaertn.) which were churned in water until foamy. In addition to being refreshing, it was said to be fattening. The fourth drink, ''tzone,'' was made from cooked seeds of ''cacao'' and ''grano indio.'' Hernández reported ''cacao'' as intermediate (''templado'') on the hot–cold scale. According to Acosta (1945, in Florescano 1983), annual tributes of ''cacao'' seeds came from both the Pacific coast (present–day states of Michoacan and Guerrero) and the Gulf coast (present–day state of Veracruz) (Fig. 5).

Today, ''cacao'' is grown in the warm, humid tropical zones on the Pacific coast in Guerrero and Chiapas and on the Gulf coast in southern Veracruz, adjacent Oaxaca, Tabasco, and adjacent Chiapas (Fig. 5) (García and Falcón 1986; Niembro 1986). Three cultivars of *T. cacao* are grown in Mexico today (Braudeau 1970): ''criollo,'' ''forastero amazónico'' (''cacao ceilán'' or ''cacao Costa Rica''), and ''trinitario.'' Of these, the ''criollo'' was probably domesticated in Mexico during pre–Columbian times from plants originating from the lower eastern

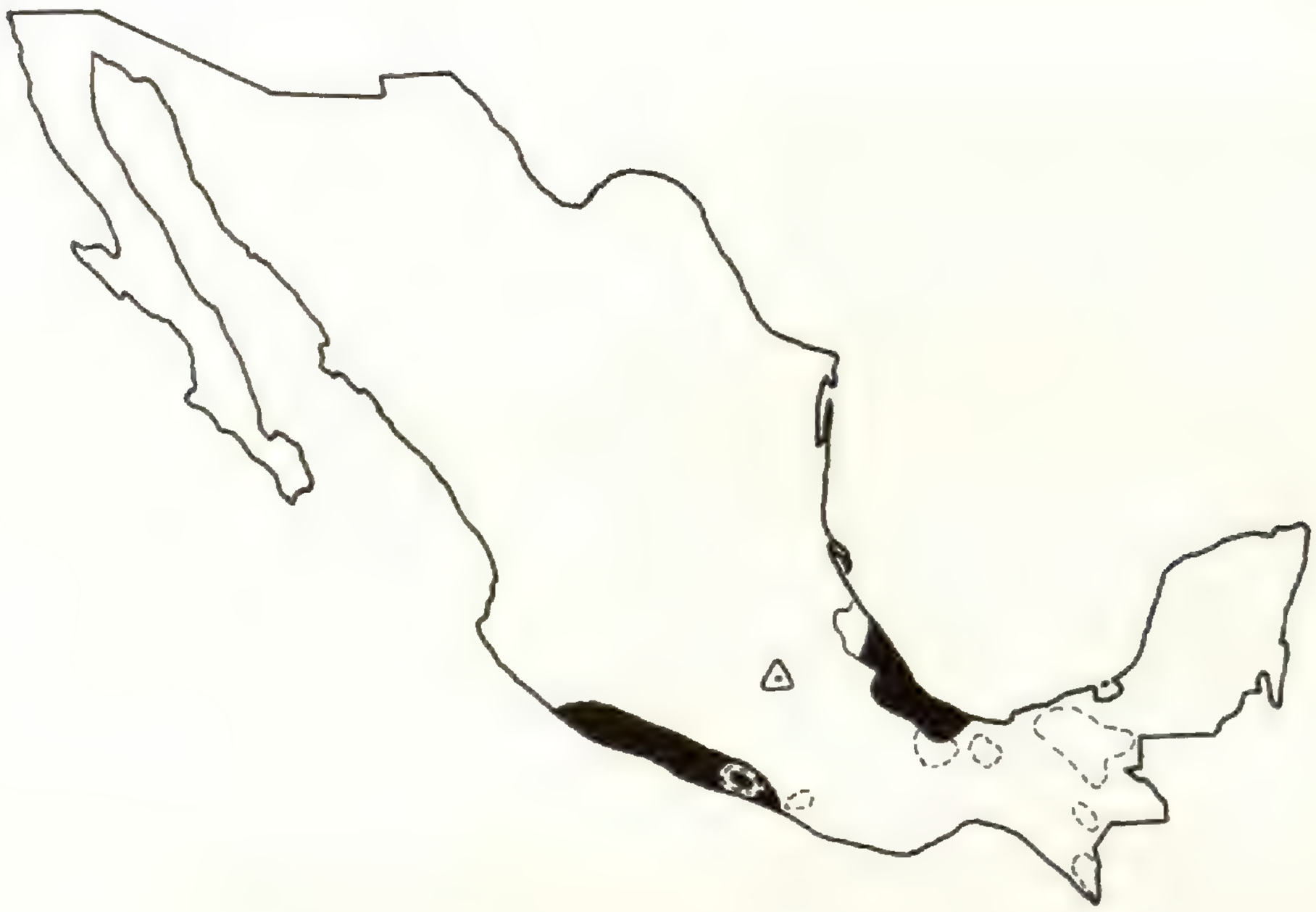

FIG. 5.—Distribution of source areas (solid) of "cacao" tribute (after Acosta 1945) and of current commercial production (line) of "cacao" seed (after García and Falcón 1986) in Mexico.

equatorial slopes of the South American Andes (Purseglove 1977; Simmonds 1976) and is represented by two forms: "criollo de México" and "cacao lagarto" or "cacao pentágonas."

Dried seeds of *T. cacao* are readily available in the markets throughout Mexico and are said to come from Tabasco. They are used in the manufacture of chocolate beverages, usually with milk, sugar and spices. "Chilate," "pataste," "chocolate" and other "cacao" seed-based beverages are consumed in various parts of Mexico.[2] Except for a chocolate drink administered to the mother during childbirth,[3] no medicinal uses have been reported in contemporary times. Commercial candies and flavorings are made from cocoa and chocolate derived from the "cacao" seed as is the cacao fat which is used in the production of emollients and creams (Niembro 1986). Contemporary vendors consider "chocolate" to be hot ("caliente") with reference to the hot–cold quality spectrum.

On the other hand, fresh fruits of *T. bicolor,* "pataste," are found only in the local markets near the areas of cultivation on the Pacific slope from Guerrero to Chiapas. The seeds and the surrounding pulp are added to the toasted cacao seeds and water to make a refreshing drink.[4] The inhabitants of Tabasco add the seeds and pulp to "chorote," a cold drink of cooked maize and toasted "cacao" seeds, and sweets (Rodríguez 1965). Sweetmeats are prepared from the seed (Standley 1920–1926).

Theobroma cacao is known in Mexico by the following names (Martínez 1979a): "biziáa" (Zapotec), "bizoya" (Zapotec), "cacahuatl" (Nahuatl), "cacao," "cacaocuáhuitl" (Nahuatl), "cacaotero" (Nahuatl), "cacauatzaua" (Zoque), "caco"

(Mixe), ''cagua'' (Popoloc), ''cahequa'' (Purepecha), ''cajecua'' (Purepecha), ''caocauatzaua'' (Zoque), ''chudechú'' (Otomi), ''chudechu'' (Otomi), ''dehy'' (Otomi), ''haa'' (Maya), ''kakau'' (Maya), ''kako'' (Mixe), ''mamichamoya'' (Chinantec), ''mamuguía'' (Chinantec), ''mochá'' (Chinantec), ''pizoya'' (Zapotec), ''yagabisoya'' (Zapotec), ''yagabizoya'' (Zapotec), ''yagapizija'' (Zapaotc), and ''yau.''

''*Nantzinxócotl*''—This Nahuatl name for *Byrsonima crassifolia* (L.) HBK. is derived from 'nantli' = mother or womb and 'xocotl' = fruit and was called ''xócotl de las madres o de las viejas.'' Valdés and Flores (1985 list only *Malpighia* sp. as the scientific name for this plant while ''segundo ahoaxócotl'' is attributed to *B. crassifolia*. This shrub was reported from warm regions of New Spain (Hernández 1959: II:30). The edible fruits were bland but agreeable. The powdered bark was used to cure ulcers (sores), to reduce swollen legs, and in childbirth. In the market, the bark of ''nantzinxócotl'' was sold in a medicinal concoction to aid digestion, clean the stomach, increase appetite, purge the uterus, induce the production of milk, and give new mothers energy. This mixture also included the following unidentified plants: ''tlatlacótic,'' ''cuicuitlapilli,'' ''tlapalezquáhuitl,'' ''chichicpatli,'' ''tzatzayanalquíltic,'' ''iztacpatli,'' ''tlalcapolin,'' ''coapatli,'' ''cicimátic,'' ''hueipatli'' ''poztequizpatli,'' and ''atepocapatli.'' Hernández reported ''nantzinxócotl'' bark as being cold (''fría'').

''Nanche'' is a native shrub of the deciduous tropical forest of both Mexican coasts from southern Tamaulipas and central Sinaloa through Chiapas and the Yucatan peninsula where it may also be protected[5] or cultivated (Pennington and Sarukhán 1968; Standley 1920–1926) (Fig. 6). From April through October, youths collect the fruits from wild plants and sell them in local markets (Pennington and Sarukhán 1968; Rose 1899). These fruits are transported to the major markets of the principal cities of Campeche,[6] Guerrero, Morelos and the Federal District [6] where the prices increase four times (Sánchez 1988). Different forms varying in color (yellow, green, pink and purple) and taste (sweet, acid and astringent) are known (Pennington and Sarukhán 1968; Sánchez 1988). Recently the shrubs have been planted for commercial,[5] ornamental[7] and reforestation purposes (Niembro 1986; Sánchez 1988). People who appreciate the mildly bittersweet fruits eat them raw, prepared in fresh and fermented drinks, candies and ice creams, or preserved in liquors and vinegars[8] (Martínez 1979b; Pennington and Sarukhán 1968; Sánchez 1988; Standley 1920–1926). The cooked fruits are added to chicken stews, soups and tamales (Rose 1899). Mexicans have used the tannin rich bark for tanning and dyeing and as a source of a strong fiber (Standley 1920–1926). Rural residents employ medicinally various parts of the plant for colds, diarrhea, fevers, and snakebites (Niembro 1986; Standley 1920–1926). Martínez (1969) reports that the concoction of the bark with rhubarb (*Rheum* sp.) and lemon peel (*Citrus* sp.) is used to treat infected gums and diarrhea and to tone intestinal muscle. To date, we have not documented the bark of ''nanche'' being sold in the market for curative purposes. The hard, flexible wood is used for firewood, charcoal, furniture, tool handles, and building construction (Niembro 1986). Market vendors say that the fruits are cool (''fresca'') on the hot-cold scale.

FIG. 6.—Natural distribution of *Byrsonima crassifolia* in Mexico (after Pennington and Sarukhán 1968).

Today, *B. crassifolia* is known by the following common names (Martínez 1979a; Pennington and Sarukhán 1968; Standley 1920–1926; Velásquez 1978): "changunga," "changungo," "chengua," 'chi" (Maya), "huizaa" (Zapotec), "mamihña" (Chinantec), "nananche," "nanantze," "nance," "nance agrio," "nanche," "nanche amarillo," "nanche de perro" "nanche dulce," "nanchi," "nancis," "nandzin" (Zoque), "nantzincuahuitl" (Nahuatl), "nanzinxocotl" (Nahuatl), "nanzinquahuitl," "shangúnga" (Purepecha), "tash" (Popoloc), "u'e" (Cuicatlec), "u'eo" (Cuicatlec), "yagahuizaa" (Zapotec), and "zacpah" (Maya).

"Texócotl"—Known as "fruto de piedra" ('tetl' = stone; 'xocotl' = fruit), *Crataegus pubescens* (HBK.) Steud. (synonyms: *C. mexicana* Moc. & Sessé in DC., *C. stipulosa* (HBK.) Steud.) was reported by Hernández (1959: II:31) as a spiny tree that grew spontaneously in the mountains. The fruits were sold in the markets where the vendors peddled the rotting ones first because they had less of the wild flavor. They were of a bland taste and could be preserved by sprinkling them with "nitro" water (probably a weak solution of a local salt). These apple-like fruits were prepared with sugar or honey in various forms. The infusion of pounded sprouts was taken to cure skin eruptions and to reduce fevers, especially if mixed with sprouts of "capolin" *(Prunus serotina* Ehrh. ssp. *capuli* (Cav.) McVaugh).

Known today as "tejocote," this species grows naturally between 2000 and 3000 m in central Mexico (Fig. 7). Various cultivars with fruits varying in size and color exist. These forms are planted in and along cultivated fields[9] and near houses while spontaneous trees are usually protected. During the fall and winter, the fruits are common in the markets.[10] Mexicans eat them raw or prepared in syrup for dessert ("tejocote en almíbar"), jellies, preserves, and hot punches

(''ponche''). Rose (1899) encountered strands of fruits on *Yucca* fiber as a form of selling ''tejocotes'' in the Guadalajara market. The Mexican prepared food industry uses the fruits as a source of pectin for manufacturing jellies and jams (Niembro 1986).

FIG. 7.—Distribution of *Crataegus pubescens* by states based upon herbarium specimens in MEXU.

The leafy branches, fruits and wood from stems and roots are used medicinally and are sold frequently in the markets.[11] In the Mercado Sonora and La Merced of Mexico City, the herb vendors offer fruits either fresh or dried in disks. A decoction of the dried fruit is drunk to suppress coughing (Martínez 1969). Certain merchants combine the fruits in a dry mixture[12] called ''flores cordiales'' (which also includes ''gordolobo'' ''*Gnaphalium* spp.; ''bugambilia'' *Bougainvillea* sp.; ''eucalipto'' *Eucalyptus* spp.; and ''tabachín'' *Caesalpinia pulcherrima* (L.) Swartz) which is prepared as a tea and ingested to alleviate coughs. Some ''curanderos'' recommend drinking the infusion made from the Mexican crabapple wood and other plants (''cola de caballo'' unidentified Poaceae, *Equisetum* spp.; ''cabeza de chivo'' unidentified Cyatheaceae; ''cancerina'' *Hemiangium excelsum* (HBK.) A.C. Smith; ''guásima'' *Guazuma ulmifolia* Lam.; ''matarique'' *Psacalium* spp.; ''palo azul'' *Eysenhardtia polystachya* (Ort.) Sarg.; ''pingüica'' *Arctostaphylos pungens* HBK.; ''tlanchichinole'' *Kohleria deppeana* (Schl. & Cham.) Fritch.) to alleviate kidney ailments and female illnesses (Linares *et al.* n.d.). The infusion made from roots is said to be diuretic, antidiarrhetic and antidysenteric (Martínez 1969; Niembro 1986). The market sellers consider the fruit and sprouts to be hot (''caliente'') while the wood and root to be cool (''fresca'') on the hot–cold scale.

In addition, the local farmers value the hard, compact wood for fuel and tool handles (Niembro 1986).

Crataegus pubescens is known in Mexico by the following names (Martínez 1979a; Standley 1920–1926; specimens in MEXU): ''bilohui'' (Zapotec), ''caiasa'' (Purepecha), ''carasu'' (Purepecha), ''chisté'' (Tzotzil) ''cohuaxochitl'' (Nahuatl), ''dopini'' (Otomi), ''dopiri'' (Otomi), ''elpateshimalo'' (Chontal), ''karash'' (Purepecha), ''kerbusi'' (Purepecha), ''manzanilla,'' ''manzanillo,'' ''manzanita,'' ''manzanita tejocotera,'' ''pedyi'' (Mazahua), ''pelohuij'' (Zapotec), ''tejocote,'' ''tejocote cimarrón,'' ''tejocotl'' (Nahuatl), ''texócotl'' (Nahuatl), ''vipeni'' (Otomi) and ''yagabelohui'' (Zapotec).

''Xochinacaztli''—Valdés and Flores (1985) register ''flor de oreja'' ('xochitl' = flower; 'nacaztli' = ear) as *Cymbopetalum penduliflorum* (Dunal) Baill. Hernández (1959: III:67–68) described it as a tree (Fig. 3) from the hot country of New Spain. He specifically stated that nothing was more common in the markets than the flowers of ''xochinacaztli.'' They were highly esteemed as an additive to the chocolate beverage ''cacáoatl.'' This drink essence not only provided a delicious flavor and pleasant aroma but also was curative in that it reduced flatulence, thinned phlegm, and warmed and strengthened cold, weak stomachs and hearts.

The ''flor de oreja'' tree grows in the humid, perennial tropical forest of southern Mexico in the states of Campeche, Chiapas, Oaxaca, Tabasco, and Veracruz (Fig. 8) although northern extensions may exist in Jalisco and Guerrero. As a household remedy in Chiapas, the infusion of the flowers is drunk to aid digestion and to treat asthma (Martínez 1969). Even though there are no contemporary reports of this plant in the Mexican markets, Standley (1920–1926) notes the sale of dried flowers in Guatemalan markets.

FIG. 8.—Natural distribution of *Cymbopetalum penduliflorum* in Mexico (after Pennington and Sarukhán 1968).

The common names used for *C. penduliflorum* are (Martínez 1979a; Pennington and Sarukhán 1968; specimens in MEXU); ''flor de oreja,'' ''guineillo,'' ''guineillo prieto,'' ''guineo de montaña,'' ''hueynacastli'' (Nahuatl), ''hueynacaztli'' (Nahuatl), ''orejuela,'' ''orejuelo,'' ''orifela,'' ''platanillo'' ''sochinacastle'' (Nahuatl), ''xochinacaztle'' (Nahuatl), and ''xochinacaztli'' (Nahuatl).

FIG. 9.—Distribution of *Guilleminea densa* by states based upon herbarium specimens in MEXU.

''Tianquizpepetla''—Although not mentioned as a plant of commerce, this name as recorded by Hernández (1959: III:144–145) suggests that it was associated with the markets. Also known as ''alfombra del los mercados'' ('tianquiztli' = market; 'pepetla' = fiber mat), it has no recorded scientific name (Valdés and Flores 1985). A synonym was ''tececequi'' ('tetl' = rock; 'cecec' = cold; ''c' or 'qui' = over) because of the habitat where it grew. *Guilleminea densa* (Willd.) Moq. (synonyms, *G. illecebroides HBK., Brayulinea densa* (Willd.) Small) and *Alternanthera repens* (L.) Kuntze (synonym, *A. achyrantha* (L.) R. Br.) are the best candidates for this plant. Hernández reported that this herb (Fig. 4) grew flat and covered the soil anywhere regardless of the climate. Although not analyzed, there were two other classes of ''tianquizpepetla'': ''chalcuítlatl'' ('cuitlati' = excrement) also known as ''estiércol crepitante'' or ''tianquizpepetla menor'' (Hernández 1959: II:235) identified as *Alternanthera repens* (Valdés and Flores 1985) and ''segundo tlalocoxóchitl'' ('tlalli' = earth, field; 'ocoxóchtil' derived from 'ocotl' = pine and 'xocthil' = flower) (Hernández 1959: II:108–109). The latter plant, ''ocoxóchitl,'' may refer to *Galium* sp. (Valdés and Flores 1985).

Because of their thick roots and prostrate branches with the leaves pressed flat to the ground, these perennial herbs could thrive in heavily travelled areas such as the market plazas where other plants would fail to survive. Today, both species are distributed widely throughout Mexico (Figs. 9–10) and are associated with disturbed habitats, especially sites with heavy trampling where most plants would be crushed to death. Other plants with similar habits, habitats and names include (Martínez 1979a): *Euphorbia heterophylla* L. and *Plumbago pulchella* Boiss. Detailed comparative analyses of the uses and characteristics of *G. densa* and *A. repens* are not made because Hernández did not consider "tianquizpepetla" a plant of commerce.

FIG. 10.—Distribution of *Alternanthera repens* by states based upon herbarium specimens in MEXU.

DISCUSSION

The five plants that Hernández reported from the early colonial Mexican markets reflect different patterns. Using Tenochtitlan (present-day downtown Mexico City) as the center of the Aztec Empire, three of the four commercial plants originated from the distant periphery while one was found on the surrounding mountains. The fifth plant was an ecological associate of the disturbed market sites. Using the species as the thematic unit and the cultural, ecological and evolutionary characteristics to define the context, limited evidence for the continuity of market plants is found even though names and uses are comparable in the 16th and 20th centuries.

"Cacahoaquáhuitl" of the 16th century is known as "cacao" today. Although the seeds are important in international trade as a source of vegetable extracts, they are no longer used as currency. Mexicans still consume cold and hot

beverages prepared from the seeds but the recipes are different from those described by Hernández except for that of "chilate" and for the addition of vanilla. The hot–cold classification of chocolate changed from being intermediate to being hot. The trees are still cultivated in the tropical regions of Mexico and the seeds are sold in the Mexico City markets and in local markets. However, the knowledge of its applications and properties in contemporary medicine has not persisted in the center. The number of domesticated forms of the past is equal to that found today but it is not possible to determine if they are the same cultivars. As in the 16th century, the center depends upon the cultivation of this plant in the tropical perhiphery.

"Nantzinxócotl" of the past is the "nanche" of contemporary dry tropical Mexico. The 16th century commercial remedy prepared from the bark is not known in the modern markets. However, one of the early colonial medicinal uses, that to aid digestion, is still appreciated in rural Mexico. Although the edible fruits were not listed by Hernández as items of commerce, Mexicans today purchase them in both central and local markets. Hernández did not record the management practices and the diversity of fruit forms that are known today. Either he was not aware of them or they did not exist in the 16th century. The medicinal bark product of "nanche" from the dry tropical periphery has disappeared from the center while the diversified edible fruits have entered contemporary central Mexican commerce.

The last tropical periphery element reported in the central markets of the 16th century is "xochinacaztli" which is still known as "xochinacaztle" and "flor de oreja." The dried flowers, once considered to be the most common element of the central market, have disappeared from trade in central Mexico. Today the only use which is comparable to that of the past is the medicinal infusion drunk to aid digestion. The flowers of this humid tropical tree, restricted to the extreme southern limit of the Aztec Empire, disappeared commercially from the central markets where it had been valued as a major flavor additive to chocolate beverages. Further inquiry is needed to understand why this chocolate complement was abandoned and why vanilla was not.

An example in our study that comes closest to demonstrating continuity is that of "texócotl" which is known today as "tejocote." Also, it is the only near–center plant recorded historically from the central market. In addition to retaining its name, though modified, the marketed fruits continue to be eaten and prepared in the same form as in the past. As a medicinal plant, the same parts are used even though they were not registered from the central market in the past nor are their uses and combinations similar. This tree still grows in the temperate climate of the mountains surrounding Mexico City. As in the case of "nanche," Hernández did not record the various management practices and evolutionary forms that are known today, thus leaving open to discussion historical inaccuracy versus intensification of ethnobotanical processes during the last 400 years.

"Tianquizpepetla" due to its ecological tolerance of intensively perturbed habitats was a common element of indirect importance to the market. Many open urban areas today provide habitats similar to those of the 16th century and are covered with both species of these prostrate perennial herbs. However, they are

not found growing on the asphalt and concrete floors of contemporary Mexico City's markets.

With the partial exception of *Theobroma cacao,* the three market plants of peripheral origin lack continuity of use today. This situation may have resulted from a failure in the market system of the Aztec Empire, prior to or after the Spanish Conquest. If we assume that the trade of market items is one of the provisioning mechanism associated with the reinforcement of relationships within the society (Hirth 1984), the weakening of the Triple Alliance exchange system, which included one cultivated and two wild tropical lowland plants, suggests correlated cultural changes due to difficulty of maintaining the center–periphery trade interactions (e.g., disintegration of socioeconomic ties, restriction of suppliers, decline of transport systems) and/or to altered cultural appreciation of the products (e.g., lack of demand, product substitution, change of preference). The cause–and–effect relationships between center–periphery market exchange and sociocultural development merits detailed examination in the future.

One response to eliminate trade dependence upon distant plants is to bring them into a local agricultural system. The lack of cultivation of these peripheral plants in the center may reflect the limitations dictated by biological factors that were stronger than the Aztec technological capability to deal with them. The royal gardens contained a great diversity of plants from all parts of the Triple Alliance Empire and illustrated its advanced horticultural ability (Paso y Troncoso 1883–1884). For example, a peripheral tropical tree (''flor de manita'' or *Chiranthodendron pentadactylon* Larreat.) was cultivated in pre-Hispanic Aztec royal gardens of the center (e.g., Tenochtitlan) and persists in the Valley of Mexico (Bye and Linares 1987). Apparently the highly desirable *Cymbopetalum penduliflorum,* the money–bearing *Theobroma cacao* and the medicinal *Byrsonima crassifolia,* all of the tropics, defied cultivation by the royal horticulturists in the temperate climate of the Empire's center. Consequently, the Triple Alliance merchants were forced to import these products from the tropical periphery.

The apparent lack of early colonial documentation of fruit diversification for *Byrsonima crassifolia* and *Crataegus pubescens* indicates the need for more detailed analysis of the historical documents. Were the Spaniards unable to detect products of the various stages of Mesoamerican domestication processes or was there rapid evolution of these plants directed by human selection following the Spanish Conquest? The recognition by Hernández of different cultivars of *Theobroma* suggests that the early Spanish chroniclers in Mexico were able to distinguish genetically different forms; hence, the latter explanation of intensified domestication of these plants after the Conquest may be more plausible.

CONCLUSIONS

Francisco Hernández recorded four vegetal products (three from the tropical periphery of the Aztec Empire and one from the temperate mountains near its political and economic center) and one ecological associate from the central Mexican markets during the period 1571 and 1576. The commerical plants include: ''cacahoaquâhuitl'' *(Theobroma cacao),* ''nantzinxôcotl'' *(Byrsonima crassifolia),*

"texócotl" *(Crataegus pubescens),* and "xochinacaztli" *'Cymbopetalum penduliflorum)* while the market floor was carpeted by "tianquizpepetla" *(Guilleminea densa* and *Alternanthera repens).* The botanical identifications of "nantzinxócotl" and "tianquizpepetla" described by Hernández represent new reports.

Although some of the uses for these plants are comparable and the current common names are derived from earlier Nahuatl terms, we suggest that there is limited continuity of the market plant products and uses from the 16th century to the present. The current sale of the plant parts not documented earlier in the market or the disappearance of the plant from the central market while its use is maintained at the local level may indicate comparable cultural value but these situations probably represent disjunctions due to different socioeconomic contexts. Only the tropical "cacao" seeds for beverages and the edible temperate "tejocote" fruits provide limited evidence for continuity of the Aztec market plants. The disappearance of other uses of "cacao" and of the aromatic flowers of "flor de oreja" and the medicinal bark of "nanche" may have been due to the weakening of the market relationships between the center and the periphery.

ACKNOWLEDGEMENTS

We acknowledge the valuable help and hospitality of our collaborators and vendors in various Mexican markets that we have visited, especially those in the Valley of Mexico. We thank the curators and staff of the Herbario Nacional (MEXU) for maintenance of and access to the herbarium specimens. Felipe Villegas M., illustrator of the Instituto de Biología, drew the final version of the maps. The importance of center–periphery and of continuity–disjunction to ethnobotanical problems was brought to our attention by colleagues of the Mesoamerican Archive and Reserach Project of the University of Colorado, Boulder, especially Davíd Carrasco (Director), Doris Heyden, Anthony Aveni, Eduardo Matos Moctezuma, Johanna Broda, and Peter van der Loo. Margarita Kay and Willard Van Asdall provided useful comments on the manuscript.

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SPECIAL NOTE

We dedicate this article to Dr. C. Earle Smith, Jr., whose conversations on Mexican plants stimulated our curiosity about the continuity of ethnobotanical processes over evolutionary time and about the poorly known, yet culturally important, tropical food plants such as *Byrsonima crassifolia:*

NOTES

[1]Margarita A. Kay, R.N., Ph.D., College of Nursing, University of Arizona, Tucson, AZ 85721.

[2]*Bye & Linares 12068:* Market, Campeche, Campeche; 31 March 1983. *T. cacao* (''cacao'') from Pichucalco, Chiapas, used to make beverage. *Bye & Linares 16745:* Market, Guanajuato, Guanajuato; 11 December 1988. *T. cacao* used to make ''chocolate casero'' beverage.

[3]Notes from Mercado Sonora, Mexico City, DF; 6 June 1982. Hot beverage of ''chocolate,'' ''yerba dulce'' (*Lippia dulcis* Trev.; *Bye & Linares 11140:* ''canela'' (*Cinnamomum* spp.), and ''retama'' (*Cassia laevigata* Willd.) drunk to promote child delivery.

[4]*Bye, Flaster & McCaleb 16102:* Market, Ayutla, Guerrero; 18 March 1988. *Bye & Rendón 16261 & 16260:* Market, Ayutla, Guerrero; 1 July 1988. *T. cacao* (''cacao'' from Tabasco) and *T. bicolor* (''quapataite'' grown locally), respectively, used to make ''chilate.''

[5]*Bye, Flaster & McCaleb 16095:* Protected tree on hill top S of Ayutla, Guerrero; 18 March 1988. *Bye & Rendón 16258:* Market, Ayutla, Guerrero; 1 July 1988. Fresh fruit from cultivated ''nanche;'' yields all year round with irrigation.

[6]Observed in Mercado La Merced, Mexico City, DF, various years. *Bye & Linares 12128:* Market, Campeche, Campeche; 3 April 1983. Fresh fruits of ''nance'' from local shrubs.

[7]*Bye & Linares 15346:* Quintana Roo, Cozumel; 21 April 1987. Cultivated ''nance'' in main plaza.

[8]*Bye & Linares 12053:* Market, Campeche, Campeche; 31 March 1983. Fruits of ''nance'' prepared in vinegar.

[9]*Bye & Linares 16088:* Santa Catarina del Monte, Texcoco, Mexico; 14 March 1988. Semi-domesticated ''tejocote'' along margin of cultivated field.

[10]*Bye & Linares 10686:* Mercado Sonora, Mexico City, DF; 13 February 1982. Fresh ''tejocote'' fruits. *Bye & Linares 11575:* Market, Xalapa, Veracruz; 8 October 1982. Fresh ''tejocote'' fruits.

[11]*Bye & Linares 11689:* Mercado Sonora, Mexico City, DF; 13 November 1982. Roots of ''tejocote'' used medicinally. *Bye & Linares 12039:* Mercado Sonora, Mexico City, DF; 6 March 1983. Tender shoots of ''tejocote'' used medicinally coughs; is ''caliente.''

[12]*Bye & Linares 16055:* Mercado Sonora, Mexico City, DF; 6 February 1988. Compuesto de flores cordiales.

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ANTELOPE, DEER, BIGHORN SHEEP AND MOUNTAIN GOATS: A GUIDE TO THE CARPALS

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ABSTRACT.—Remains of antelope, deer, mountain goat, and bighorn sheep appear in archaeological sites in the North American west. Carpal bones of these animals are generally recovered in excellent condition but are rarely identified beyond the classification "small-sized artiodactyl." This guide, based on the analysis of over thirty modern specimens, is intended as an aid in the identification of these remains for archaeological and biogeographical studies.

RESUMEN.—Se han encontrado restos de antilopes, ciervos, cabras de las montañas rocosas, y de carneros cimarrones en sitios arqueológicos del oeste de Norte América. Huesos carpianos de estos animales se recuperan, por lo general, en excelentes condiciones pero raramente son identificados más allá de la clasificación "artiodactilos pequeño." Esta guía, basada en un análisis de más de treinta especímenes modernos, tiene el propósito de servir como ayuda en la identificación de estos restos para estudios arqueológicos y biogeográficos.

RESUME.—On peut trouver des ossements d'antilopes, de cerfs, de chèvres de montagne et de mouflons des Rocheuses, dans des sites archéologiques de la région ouest de l'Amérique du Nord. Les os carpeins de ces animaux, généralement en excellente condition, sont rarement identifiés au delà du classement d' "artiodactyles de petite taille." Le but de ce guide basé sur 30 specimens récents est d'aider à identifier ces ossements pour des études archéologiques et biogéographiques.

Four genera of relatively small artiodactyls have roamed the Holocene landscapes of western North America. The remains of antelope *(Antilocapra americana),* deer *(Odocoileus hemionus* and *O. virginianus),* mountain goats *(Oreamnos americanus),* and bighorn sheep *(Ovis canadensis)* appear in various archaeological and paleontological deposits in the West (e.g., Grayson 1985, 1988; King 1950; Sinclair 1904). Throughout western North America, the distributions of these animals overlap, at least in part. In areas of the Great Basin, for instance, antelope, deer and bighorn sheep have coincident distributions (Hall 1981). These three genera are typically found together in archaeological sites in the Great Basin (e.g., Grayson 1988) and in eastern Washington (e.g., Livingston 1985). On the northwest coast, the distributions of deer, bighorn sheep, and mountain goat overlap (Hall 1981) and all may be represented in one archaeological site (King 1950).

Post-cranial remains of these genera are often difficult to distinguish. In addition, the condition of archaeological faunal material and incomplete comparative collections often preclude the generic or specific identification of the bones in question. Several zoologists and archaeologists have described criteria for identification of elements of these genera (e.g., Gilbert 1980; Hildebrand 1955; Lawrence 1951; Sandefur 1977), but with one exception (Sandefur 1977), carpals are not included in available guides.

Carpals are small dense bones that make up the joint between the lower fore limb and the metacarpals (Fig. 1). In artiodactyls, this joint is tightly bound together by soft tissue. Because carpals are dense, they do not deteriorate as rapidly as other elements after the death of the animal (Brain 1981). They occur frequently in archaeological deposits but are often lumped under the taxonomic category "small-sized artiodactyl" during analysis. The identification of these elements to genus will aid subsistence studies about the variable treatment of carcasses. Additionally, biogeographical studies of these genera (e.g., Lyman 1988) may be advanced by the use of this tool.

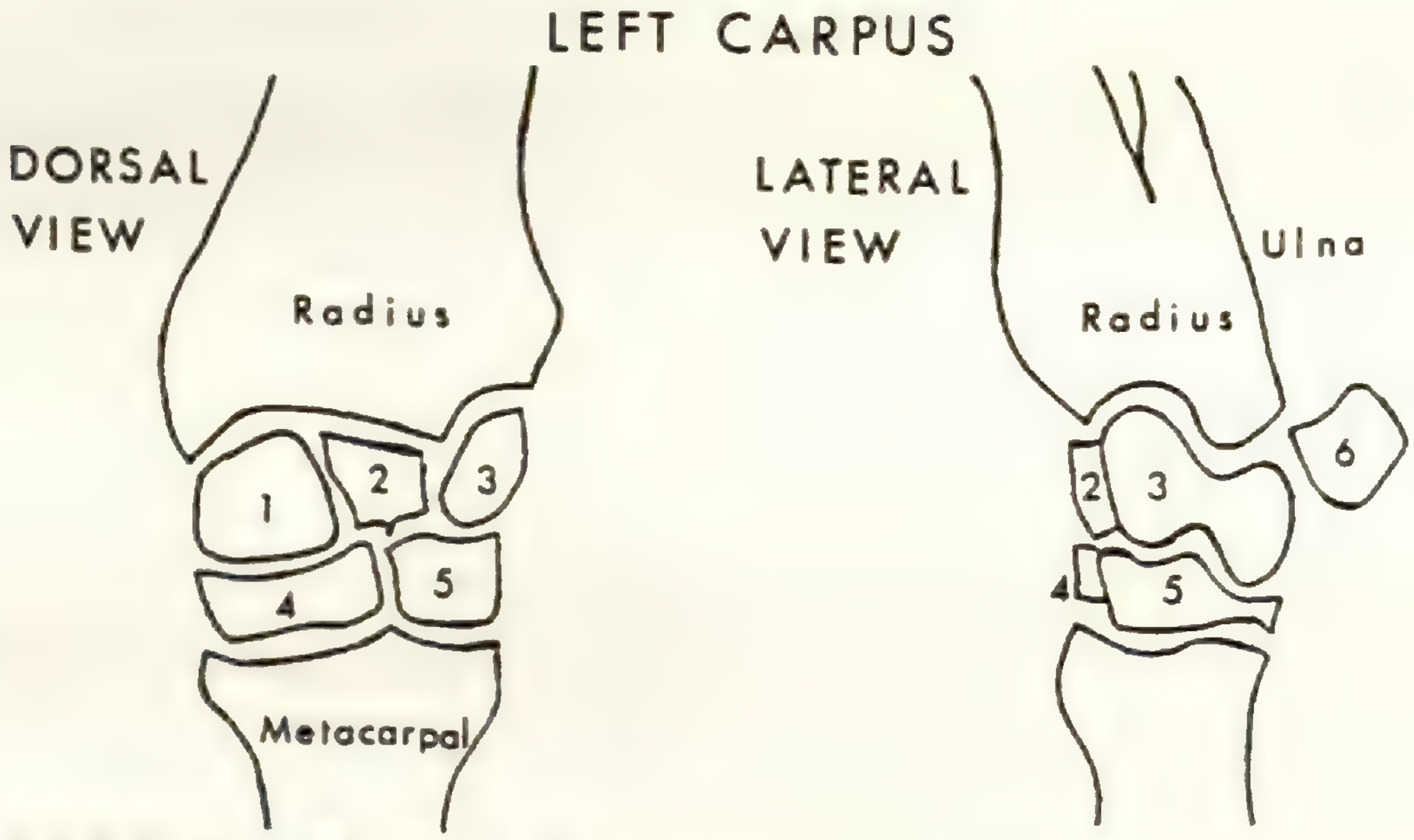


FIG. 1.—Relationship of various carpals to the radius and metacarpal in artiodactyls.

This guide is intended for use in conjunction with comparative skeletons for the identification of carpals recovered from archaeological and paleontological deposits. Few analysts have extensive collections of artiodactyls available and comparison of one archaeological carpal with one modern specimen of each genus may not allow the secure identification of the archaeological specimen. The purpose of this guide is to illustrate the characteristics that appear on carpals of various genera, but which might not be evident when examining single specimens. I initially utilized 31 skeletons from the collections of the Museum of Comparative

Zoology at Harvard University, the Thomas Burke Memorial Washington State Museum, and private collections to determine useful and valid distinguishing criteria. Carpals from twelve of these were used for the drawings in Figures 2–10. The drawings were compared with an additional set of seven modern specimens. Further analyses by others may bring to light additional distinctive criteria and require revisions in this guide.

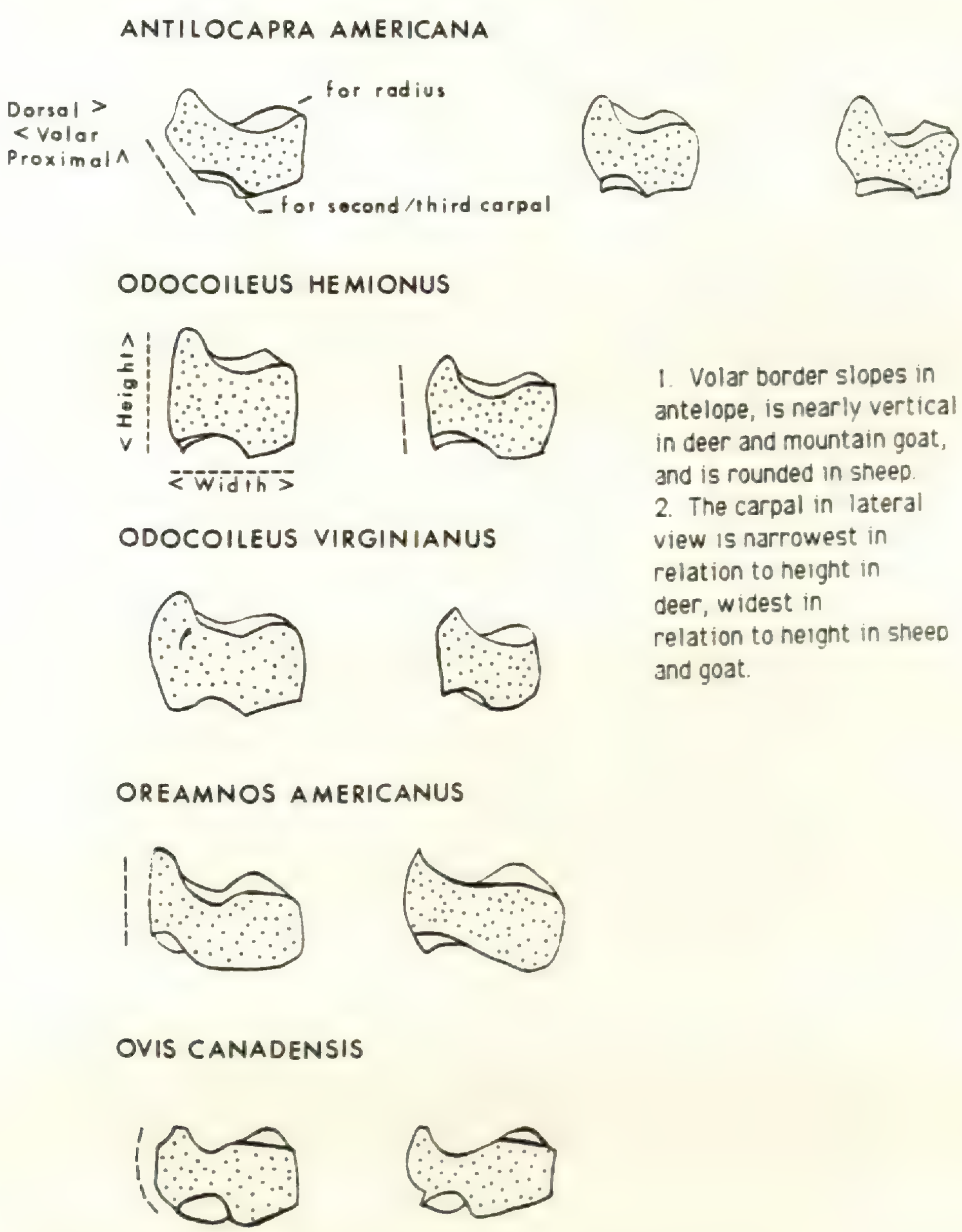


FIG. 2.—Radial carpal, lateral view.

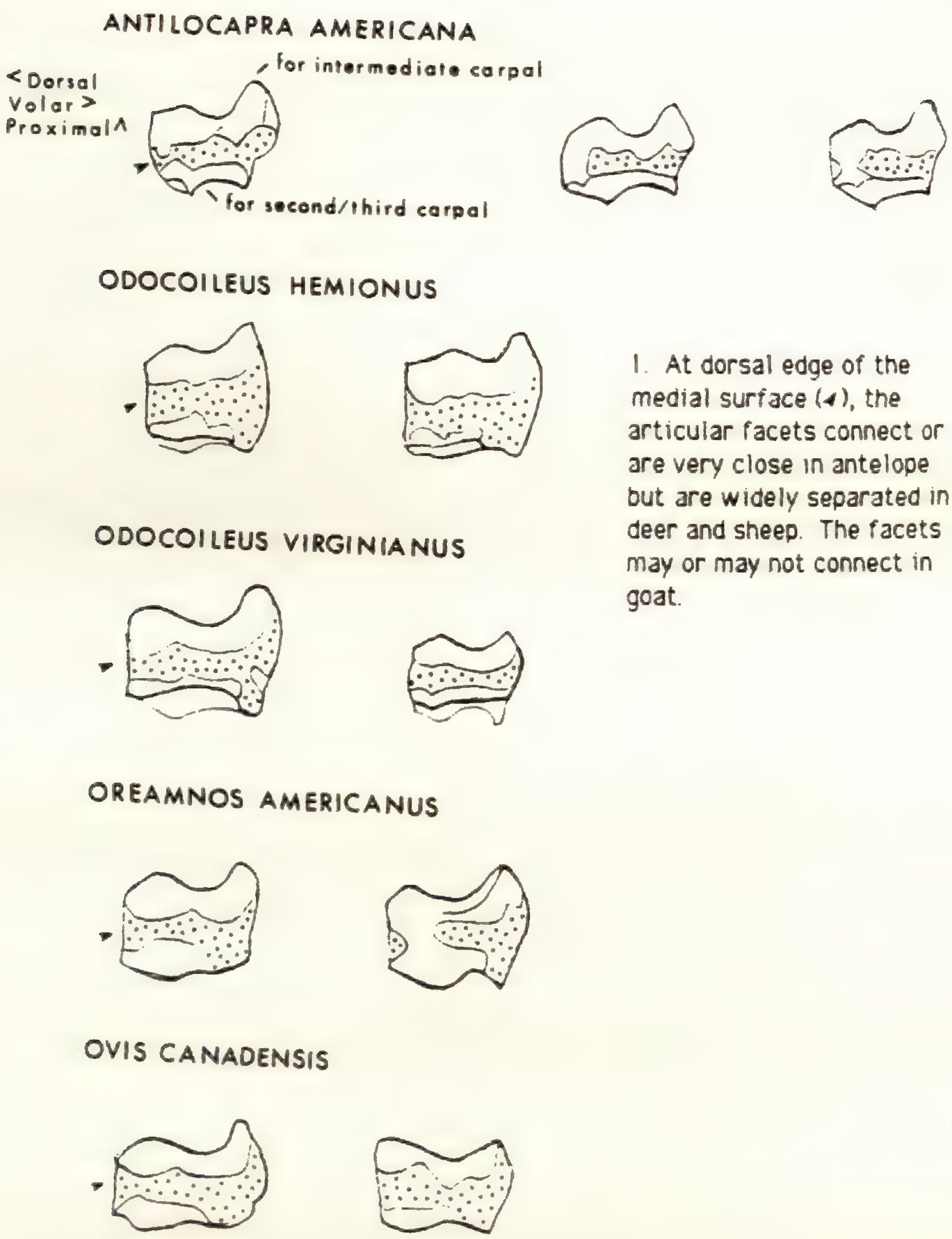
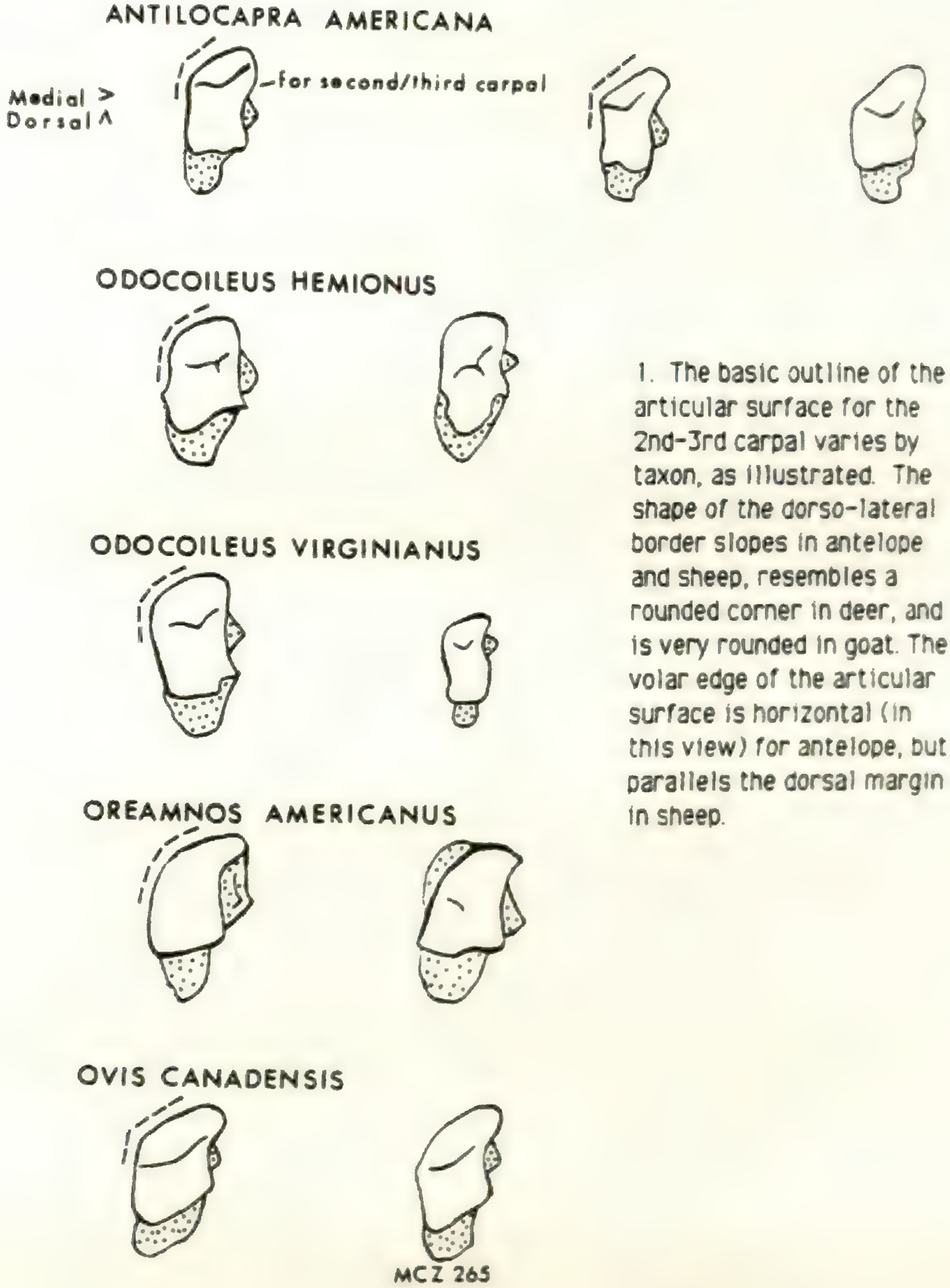
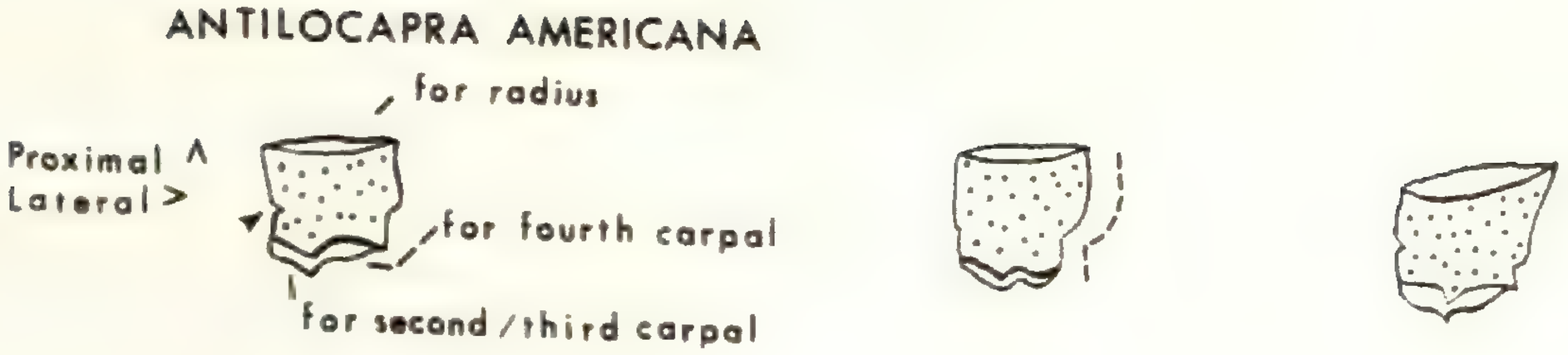


FIG. 3.—Radial carpal, medial view.



1. The basic outline of the articular surface for the 2nd-3rd carpal varies by taxon, as illustrated. The shape of the dorso-lateral border slopes in antelope and sheep, resembles a rounded corner in deer, and is very rounded in goat. The volar edge of the articular surface is horizontal (in this view) for antelope, but parallels the dorsal margin in sheep.

FIG. 4.—Radial carpal, distal view.



1. When the carpus is articulated, the shaded area is visible. The basic outline of the shaded area varies by taxon, as illustrated. In antelope, width and height of visible surface are approximately equal. In deer, height is greater than width. In sheep and goat, width is greater than height.
2. In antelope, the notch at ◂ on medial border is just below the midpoint of the bone. In deer, the notch on the medial border is longer than in other taxa and turns up slightly at the distal end of the notch. In sheep and goat, the notch is concave and the distal end of the notch borders on the articular surface for the 2nd-3rd carpal.

FIG. 5.—Intermediate carpal, dorsal view.

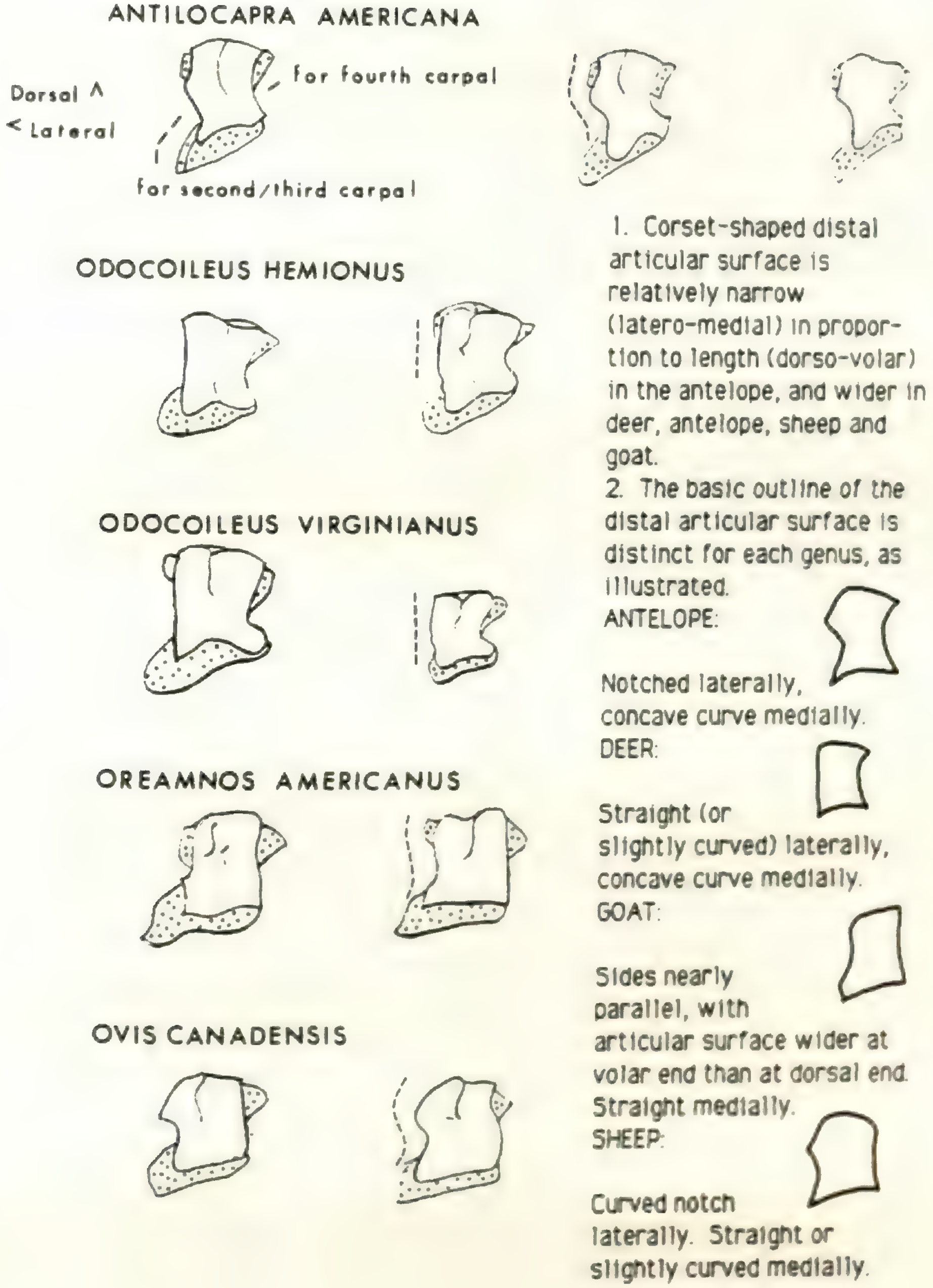
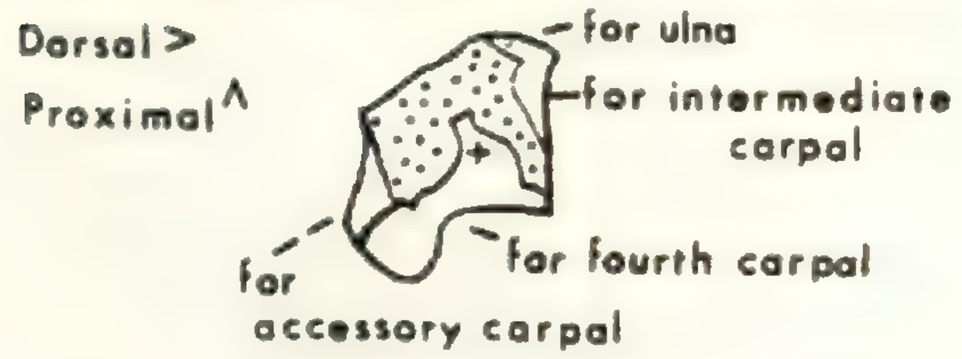


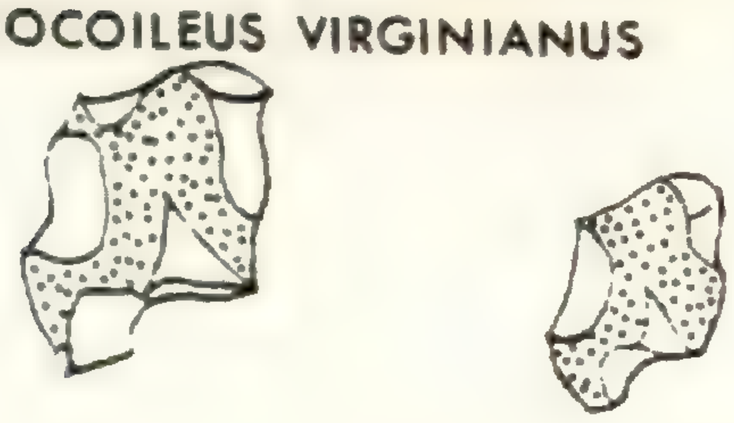
FIG. 6.—Intermediate carpal, distal view.

ANTILOCAPRA AMERICANA



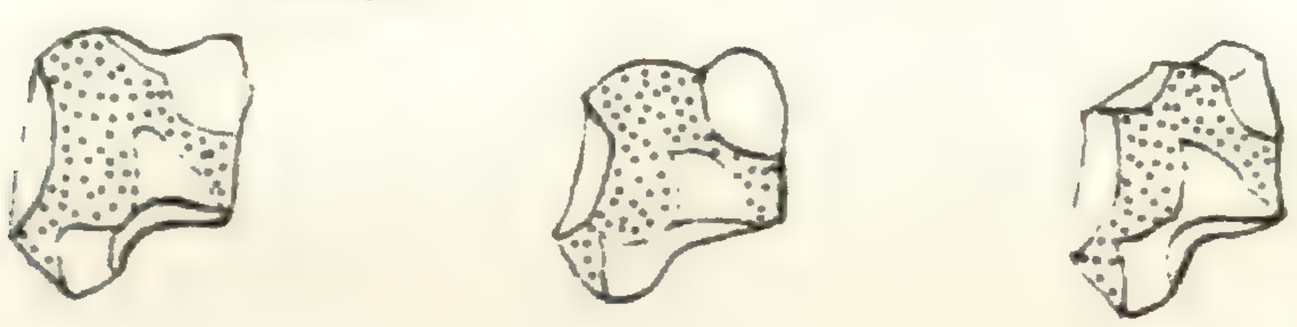
ODOCOILEUS HEMIONUS

ODOCOILEUS VIRGINIANUS



OREAMNOS AMERICANUS

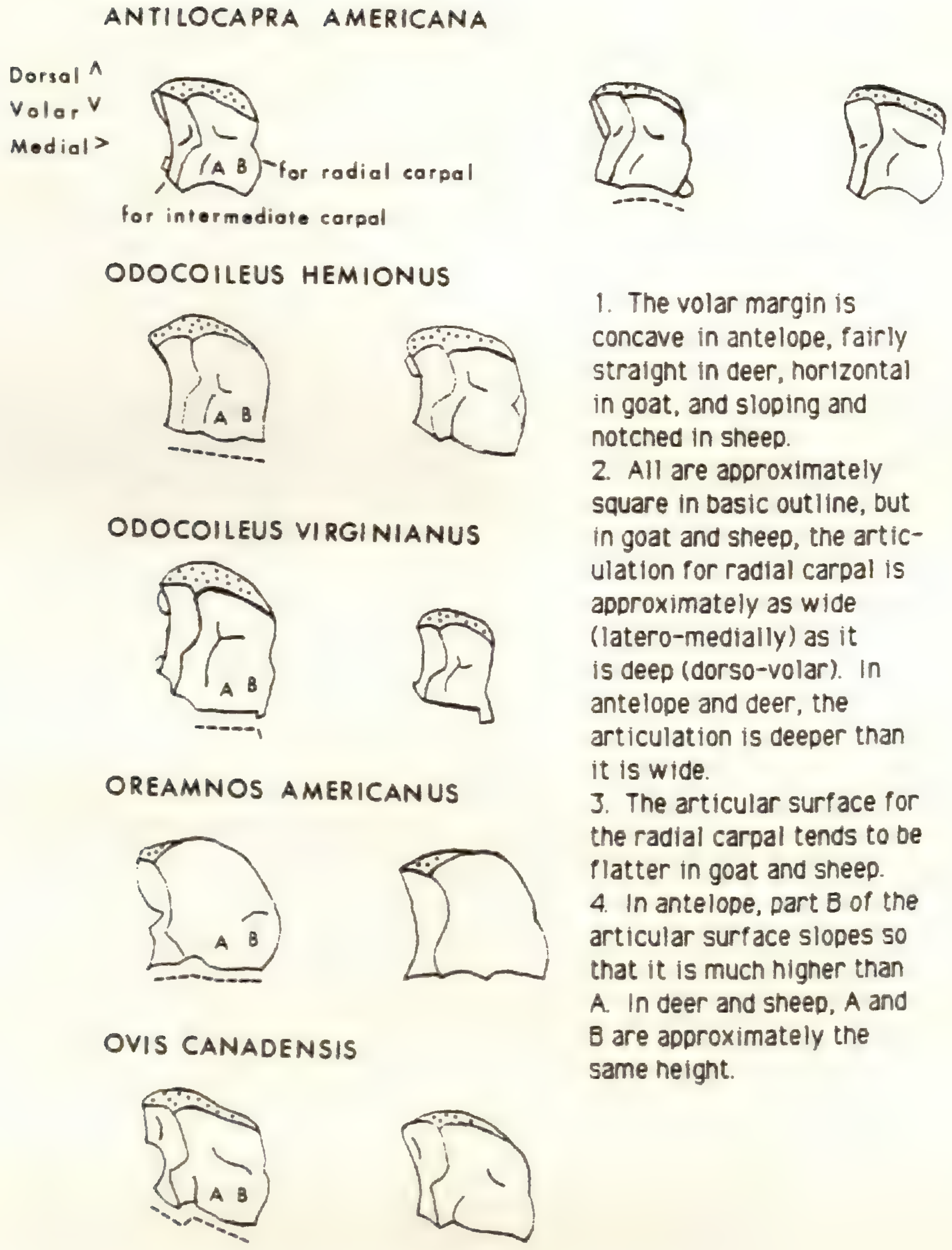
OVIS CANADENSIS



1. At +, the most proximal part of the facet protrudes medially only in antelope and deer but remains flush with the carpal in sheep and goat. There are antelope carpals on which it remains flush.
2. The most distal medial facet for the fourth carpal slopes distally and medially in antelope, medially and towards the volar in deer, dorso-medially in goat, and medially in sheep.

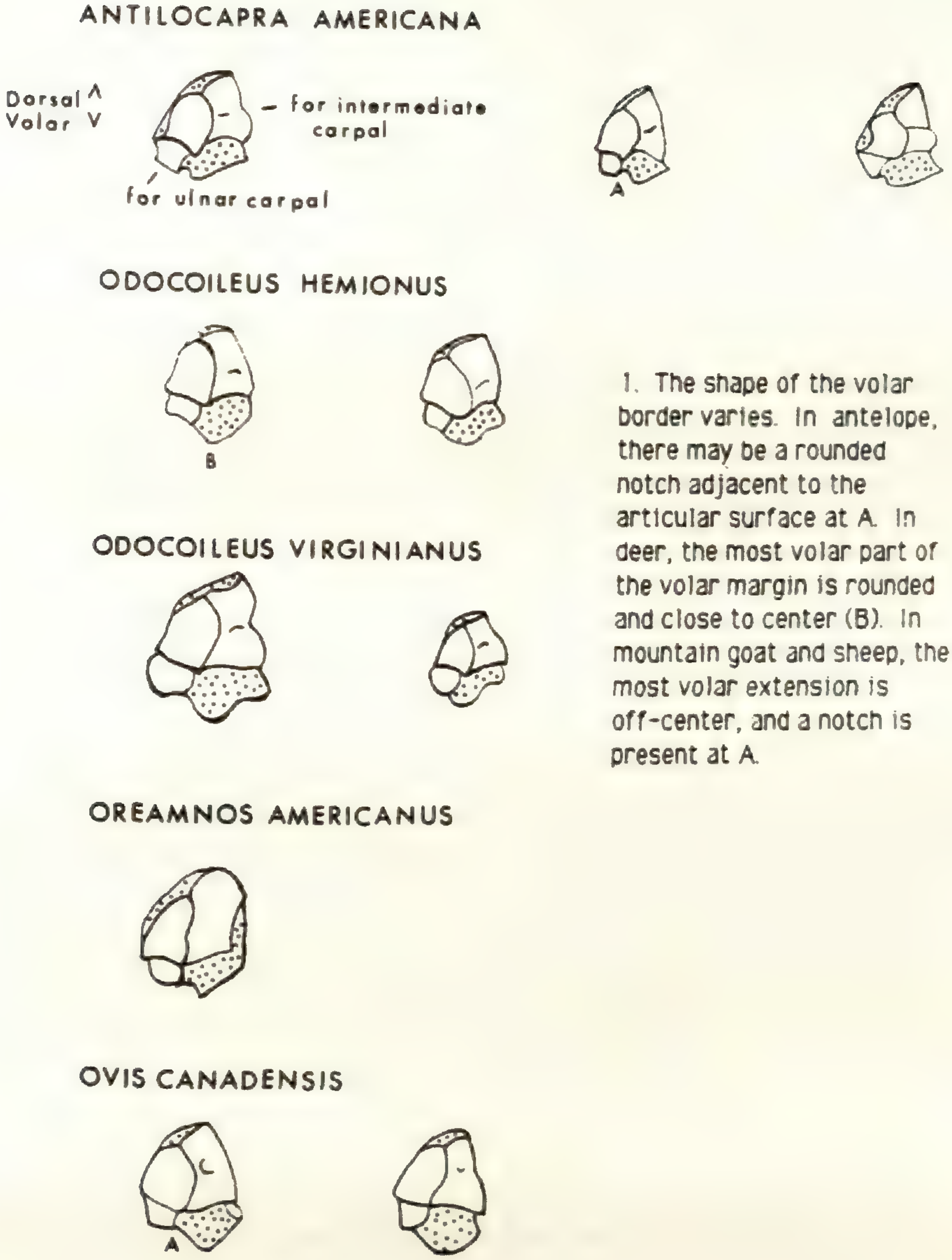
FIG. 7.—Ulnar carpal, medial view.

FIG. 8.—Accessory carpal, medial view.



1. The volar margin is concave in antelope, fairly straight in deer, horizontal in goat, and sloping and notched in sheep.
2. All are approximately square in basic outline, but in goat and sheep, the articulation for radial carpal is approximately as wide (latero-medially) as it is deep (dorso-volar). In antelope and deer, the articulation is deeper than it is wide.
3. The articular surface for the radial carpal tends to be flatter in goat and sheep.
4. In antelope, part B of the articular surface slopes so that it is much higher than A. In deer and sheep, A and B are approximately the same height.

FIG. 9.—Second/third carpal, proximal view.



1. The shape of the volar border varies. In antelope, there may be a rounded notch adjacent to the articular surface at A. In deer, the most volar part of the volar margin is rounded and close to center (B). In mountain goat and sheep, the most volar extension is off-center, and a notch is present at A.

FIG. 10.—Fourth carpal, proximal view.

Various views of at least two each of all six carpals illustrate variation within and between the five species (Figures 2–10). Male and female are represented for each species, with the exception of mountain goat, for which specimens are either female or gender unknown. No attempt has been made to determine species-level criteria for the deer. All the specimens are from the left side. Articular surfaces on each are indicated by white: all other surfaces are shaded. Anatomical terminology is from Getty (1975) to allow consistency and eliminate confusion with human osteology terms (Table 1). Taxonomic nomenclature follows that of Jones *et al.* (1986).

TABLE 1.—Synonyms used for Carpal Bones (after Getty 1975).

Radial carpal	os scaphoideum	navicular	scaphoid
Intermediate carpal	os lunatum	semilunar	lunate
Ulnar carpal	os triquetrum	triangular	cuneiform
Accessory carpal	os pisiforme	pisiform	
Second carpal	os trapezoideum	trapezoid	lesser mult-angular
Third carpal	os capitatum	capitate	magnum
Fourth carpal	os hamatum	hamate	unciform

In the Artiodactyls, the second and third carpals fuse to form a single element. An intermedioradial carpal and a first carpal are present in other mammals (Getty 1975).

ACKNOWLEDGEMENTS

I especially thank M. Rutzmoser and M. Massaro who provided skeletons from the Museum of Comparative Zoology, Harvard University, during the 1983 summer institute on fauna by the Center for Materials Research in Archaeology and Ethnology at Massachusetts Institute of Technology. A travel and housing grant from the Center made this research possible. J. Rozdilsky of the Mammal section of the Thomas Burke Memorial Washington State Museum and R.D. Leonard also provided specimens. R.L. Lyman examined the guide in conjunction with seven additional specimens. The insights of M. Glass, D.K. Grayson, K. Juell, R.L. Lyman, R. Meadow and H.-P. Uerpmann have enhanced this guide.

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BOOK REVIEW

Recherches Amerindiennes au Quebec, Vol. XVIII No. 1, Printemps 1988: La santé en transition. (Amerindian Research in Quebec, 18(1), Spring 1988: Health in Transition). Recherches amerindiennes au Quebec, 6742 Saint Denis, Montreal, Quebec H2S 2S2, Canada. Pp. 99. $7.00 (this issue), $20.00 (regular annual subscription).

"Recherches Amerindiennes au Quebec" is a journal devoted to the dissemination of information on the Amerindians of Quebec, and to research by Quebec authors on Amerindians. Articles are published in French only, but English abstracts are provided at the back of each issue (since 12(2): 1982). Each issue has a primary theme but may also include short articles on unrelated topics. The journal has been published quarterly since 1971. It is indexed in "Abstracts in Anthropology," "Historical Abstract," "America: History and Life," and "Point de repère."

The issue "La santé en transition" is edited by Robert Larocque, Anthropology Department, University of Montreal. The seven main articles were selected to present several aspects of the relationship between diseases and cultural evolution, with a focus on the study of evidence from skeletal remains.

The first two articles discuss the health status of Amerindian populations in the transitional period of first contact with Europeans. Larocque concludes that disease had a negligible effect, in comparison to the disruption of social order, in the process of colonization. Gagné examines the high infant mortality rate at a Jesuit mission during the colonial period, and finds that malnutrition and

respiratory infections were important contributing factors, in addition to the widely reported effects of smallpox epidemics.

The transition period between the nomadic contact–traditional life style and settlement in villages is the setting for the report of Choinière *et al.*, who find that the evolution in causes of mortality of the Inuit, from infectious and parasitic diseases to cardiovascular diseases, cancer, and violent deaths, is a reflection of recent improvements in sanitary conditions and social changes related to settlement.

In the first of three practical articles that follow, Katzenberg describes the use of skeletal remains to determine the nutritional and health status of prehistoric people. Saunders provides background information on bone structure and growth, and describes how information from ancient skeleta can be applied to health problems of modern populations. Larocque provides a summary statement on the ethics of exhumation and analysis of human remains in archaeology, and follows this with the Ontario government legal situation and position statements by various professional associations of physical anthropology and archaeology.

Finally, Philie and Foggin describe the difficulties encountered by modern health care workers in northern Quebec.

By combining articles on the techniques of skeletal analysis with articles illustrating the use of these techniques for health and nutrition research, and the legal and ethical guidelines to be followed, Larocque has provided an interesting and informative issue for ethnobiologists, especially those with an orientation towards health issues and archaeology.

Other issues of "Recherches Amerindiennes au Quebec" of interest to ethnobiologists would be 9(1–2):1979, on the ecology and exploitation of caribou in Quebec and Labrador; 12(1):1982, on modern and historic native health issues; 14(1):1984, on aquatic resource exploitation by Amerindians; 15(3):1985, on hunting and wildlife management; and 17(4):1987, on ethnoscience.

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ACROCOMIA MEXICANA: PALM OF THE ANCIENT MESOAMERICANS

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ABSTRACT.—Archaeobotanical evidence for the use of *Acrocomia mexicana* (Arecaceae) fruits by prehistoric Mesoamericans is presented in this paper with a focus on recent data from the Copán site. It is a tree of disturbed habitats and one whose frequency has expanded dramatically since the arrival of the first humans in the region. Productivity assessments of *A. mexicana* show that it was capable of contributing considerably to the pre-Columbian diet, expecially in light of the high fat content found in the mesocarp and kernel portions of the fruit.

RESUMEN.—A continuación se presenta la evidencia arqueobotánica del uso de los frutos de *Acrocomia mexicana* (Arecaceae) por algunos habitantes de Mesoamérica prehistorica con un foco sobre información nueva del sitio de Copán. Este es un arbol que se da en ambientes secundarios cuya frecuencia se ha extendido dramaticamente desde la llegada de los primeros hombres a la región. Las medidas de productividad de *A. mexicana* muestran que la misma es capaz de contribuir considerablemente a la dieta pre–Colombina, especialmente en vista del alto contenido en el mesocarpo y porciones del corazón de la fruta.

RESUME.—Nous proprosons de présenter dans cet article les preuves archéobotaniques au suject des fruits *Acrocomia mexicana* (Arecaceae) utilisés par les Mesoaméricains prehistoriques avec un foyer sur la donnée récent de le site de Copán. C'est un arbre qu'on trouve dans des habitats perturbés et dont la fréquence a augmenté de facon dramatique depuis l'arrivée des premiers êtres humains dans la région. Les mesures faites sur la productivite' de l' *A. mexicana* montrent que ce fruit était capable de contribuer considerablement au régime alimentaire des pré–Colombiens, particulièrement en vertu du taux élevé en lipides contenues dans le mésocarpe et le noyau du fruit.

INTRODUCTION

It has long been supposed that the prehistoric Maya and other pre-Columbian Mesoamericans relied on more than just the often cited trinity of corn, beans and squash for their sustenance. Recent analyses of carbonized plant remains from the Copán site in western Honduras and other prehistoric sites in the region have revealed the presence of numerous economic species in archaeological deposits. Among these have been the remains of coyol (*Acrocomia mexicana* Karw. ex Mart.), a useful palm that is indigenous to the Neotropics.[1]

The common name for this tree among Mestizos throughout Central America, ''coyol,'' is of Nahuatl origin (Standley and Steyermark 1946). The Yucatec Maya call it ''tuk,'' (Roys 1931), while other Native American names for coyol include: ''maap'' (Teenek Maya)(Alcorn 1984), ''ya cul'' (Jicaque)(Lentz 1986) and ''ača'' (Paya)(Conzemius 1927).

USES OF COYOL

Today coyol is found in many parts of Central America and is commonly cultivated by Mestizos (Moore 1961). The globose fruits (3–4 cm in diameter) mature in six months and are composed of four layers: (1) the thin outermost layer or pericarp, (2) the thick, fleshy mesocarp just underneath, (3) the hard, bony endocarp and innermost, (4) the solid, white kernel or endosperm which is similar to the meat of a coconut (Fig. 1).

FIG. 1.—Scale drawing of *A. mexicana* fruit showing the exterior (left) and a transverse section showing tissue layers (right) with k = kernel or endosperm, e = endocarp, m = mesocarp and p = pericarp.

The use of coyol products has been documented for people throughout Mesoamerica. The Teenek Maya routinely spare palms that volunteer in their milpas because they value the fruit (Alcorn 1984:421). The fruit of coyol, especially the inner meat, is eaten fresh (Alcorn 1984:375) or sometimes stored in pots for later use (Alcorn 1984:128). The Yucatec Maya eat coyol kernels fresh too, and make a drink from it (Tozzer 1941:200; Roys 1931:288). According to Roys quoting the Relaciones de Yucatan:

> ... the Indians [Maya] roast them [coyol] in stew-holes and eat the pulp [mesocarp] which is on the pit. They also cook it in honey. The pit has a kernel like a very palatable hazel-nut, and this is a great benefit to the Indians in times of scarcity, because there is a great quantity of them, and they make a food and a drink which is healthy and very sustaining. [Roys 1931:288]

Roys also mentions that coyol was used as part of a remedy for blood in the urine and diabetes. For a discussion of medicinal uses for South American *Acrocomia* palms see Plotkin and Balick (1984). The Jicaque Indians of Montaña de la Flor, Honduras, have similar uses for coyol and often plant the trees in their house compounds (Lentz 1986). The Paya Indians of El Carbón, Honduras, eat coyol

fruits and make a wine from the sap of felled trees. A complete description of the process for making coyol wine can be found in Balick (1990). Likewise, Central American Mestizos consume the fruits and other coyol products. In addition to fresh consumption, wine-making, and medicinal applications, *Acrocomia* palms are good sources of oil which can be extracted from the kernel (Williams 1981:249–250) and the mesocarp (Plotkin and Balick 1984).

To get to the kernel, the bony endocarps are generally cracked open between two large stones (Standley and Steyermark 1946:201–202). Large "nutting stones" with 2–3 cm depressions have been discovered in at least two Honduran archaeological zones, Cajón and Copán (Fea. 75, Str. 9N–97). Since these would have made ideal anvils for cracking coyol "nuts," they can be considered circumstantial evidence of early coyol processing.

ARCHAEOBOTANICAL EVIDENCE

Early evidence of palm use has been found throughout the subcontinent: from Panama to Mexico (Fig. 2). The earliest report of *A. mexicana* came from the Tehuacan Valley sites, circa 4,800 B.C., in Central Mexico (Smith 1965). Other Mesoamerican archaeological sites where palm remains have been discovered are listed in Table 1.

FIG. 2.—Map of Mesoamerica showing archaeological sites where palm remains have been found.

TABLE 1.—*Mesoamerican archaeological sites with palm remains.*

Site	Date	Palm	References
Cerros, Belize	200 B.C.–A.D. 100	*Acrocomia mexicana* fruits	(Crane 1986)
Colha, Belize	A.D. 900–1,200	*A. mexicana* "shells"	(Caldwell 1980)
Cerro Palenque, Honduras	A.D. 600–900	"coyol remains"	(Joyce 1985)
Copán Valley, Honduras	A.D. 400–900	*A. mexicana* endocarps	(Lentz 1990)
El Cajón region, Honduras	200 B.C.–A.D. 900	*A. mexicana* endocarps	(Lentz 1989)
Tehuacan Valley, Mexico	4,800 B.C.	*A. mexicana* endocarps	(Smith 1967)
Aguadulce Shelter, Panama	5,000–1,000 B.C.	"palm nuts"	(Ranere and Hansell 1978)
Chiriqui, Panama	4,600–2,300 B.C.	*A. mexicana* endocarps	(Smith 1980)

In the Copán Valley, *A. mexicana* has been identified from the Ostuman site, the Los Mangos site, several small upland sites, and has been found in association with numerous structures in the Sepulturas section just east of the Main Group; the principal ceremonial complex of the Valley. All of the outlying sites are Late Classic (Coner Phase) in temporal affiliation, but in the Sepulturas section, much earlier occupational components have been found underlying the Coner Phase material. Carbonized plant remains have been analyzed from deposits dating as early as 900 B.C. (Gordon/Uir Phase).

Table 2 shows the chronological sequence of the various occupational phases encountered during the Copán excavations along with the number of archaeobotanical samples analyzed from each phase and the number of samples bearing coyol. The lack of coyol remains found before the Late Bijac/Early Acbi Transition Phase (circa A.D. 400) is interesting because it coincides with the first Maya intrusion into the Copán Pocket and approximately with the erection of the first stela in the valley (Sanders 1989).

There are three possible explanations for the absence of coyol prior to the Acbi Phase. First, but least likely, coyol remains may have been deposited in the earlier strata but not preserved. Coyol endocarps, the fruit part most frequently recovered in archaeological deposits, are among the most durable plant tissues to be found. It is also the part of the coyol fruit which is of little use and routinely discarded. The cell structure of the endocarp has a high density and, consequently, the tissue layer is very hard. Other less durable remains, such as corn cupules,

TABLE 2.—*The chronological sequence from Copán Valley excavations along with the number of archaeobotanical samples bearing A. mexicana remains.*

Occupational Phase	No. samples analyzed	No. samples with coyol
Coner phase (Late Classic) A.D. 700–900	168	74
Acbi phase (Middle Classic) A.D. 400–700	17	5
Bijac/Acbi transition A.D. 400	5	4
Bijac phase (Early Classic) A.D. 100–400	4	0
Chabij phase (Late Preclassic) 400 B.C.–A.D. 100	0	0
Gordon/Uir phase (Middle Preclassic) 900–400 B.C.	14	0

are found frequently in the Bijac and Gordon Phase deposits so even a minor utilization of coyol should have appeared in the archaeobotanical record.

Second, perhaps coyol was available in the Copán Pocket but not exploited by the pre-Maya population. It seems unlikely that the pre-Maya of Copán would have had a useful tree in their midsts and not exploited it, at least to some degree. It is possible that they had a different pattern of utilization, such as cracking open the drupes in the field, then consuming the kernel directly or perhaps bringing only the kernels back to the habitation site for consumption. As a result, the endocarp would not have been deposited at the site. This pattern of use does not allow for the use of the mesocarp, since this later generally requires more processing than the kernel, nor does it allow for storage, since the exposed kernels do not store well. Alternatively, the fruits store extremely well when left in their own natural package. If the fruits were being used and stored, then the waste portions would likely have been found in or around the habitation site. Here again, even a minor use of coyol by the pre-Maya should have produced some evidence in the archaeobotanical record.

The third and most reasonable explanation is that the Maya introduced the use of the plant into the area and possibly even brought the seeds with them. During Early Classic times the Copán Pocket was an extremely isolated area, a veritable cultural backwater probably similar to what it was like when Stephens (1963) arrived in the mid-19th century, minus the ruins, with small populations surrounded by dense stands of tropical deciduous forest. Sanders (1989) states that the Preclassic population of the valley was probably less than 1,000 people and seems to have remained that size until the Maya intrusion at the beginning of the Acbi phase (Webster and Freter 1989). Since the Copán Valley is so remote,

it seems plausible that coyol may not have migrated into the valley by means of its own dispersal mechanisms.

The natural habitat of coyol is unclear. In general, the palm is adapted to disturbed habitats (Moore 1979) and grows rapidly, eventually reaching a height of up to 15 meters. It will bear abundant fruit after 4–5 years as do its congeners (FAO 1949). Notwithstanding its characteristics as a pioneer species, it is curiously absent from traditionally recognized disturbance sites such as creek bottoms and river banks (Janzen 1971). Coyol does not compete well under constantly wet conditions as would be found in an active alluvial plain (Uhl and Dransfield 1987) and prefers well-drained areas. Slopes cleared for agriculture and open savannas are common habitats for coyol today. On the Pacific Coast, the palm will form forests of large extent, called "coyolares," but these are less common on the Atlantic Coast (Standley 1937). Cattle enjoy coyol fruits and are at least partially responsible for the widespread distribution of the palm today (Janzen 1971; Uhl and Dransfield 1987). Local farmers claim that deer also eat and disperse coyol fruits, but, if so, it must be an excruciatingly painful exercise for these small ungulates.

Although coyol does not seem to grow in disturbed habitats along streams, there are other suitable disturbed micro-habitats in even the most stable forest environments. In the case of tropical deciduous forest, which was the dominant vegetation in lowland areas during pre-settlement times for much of Central America, there must have been episodes of disturbance caused by natural calamities such as forest fires or storms causing uprooting of large trees. Such events would have opened the forest canopy and given a fast-growing species like coyol a chance to become established and set seed before being crowded out by forest dominants.

When early agriculturalists entered the region in prehistoric times, they created additional areas of disturbance and undoubtedly contributed to is expansion. Probably this occurred unintentionally at first, but as the useful properties of the plant became apparent, humans may have become more active in dispersing the seeds of coyol. Smith (1975), in a discussion of the distribution of coyol, states that its presence on both the Atlantic and Pacific Coasts of Mexico is best explained as a direct result of human activity. In any case, man has certainly played a major role in the expansion of coyol populations into new areas.

DISCUSSION

Copán provides a good example of the role coyol could have played in the prehistoric Mesoamerican dietary pattern since the valley and its prehistory have been so well studied. The drainage basin covers about 400 km^2 but, of these, only 60 km^2 can be used for maize-based agriculture (Sanders 1989). Sanders has described four landtypes suitable for agricultural production in the pocket: active alluvium, ancient alluvium, intermontane basins, and piedmont. All of these, except for the active alluvium, would have been excellent habitat for coyol following forest clearance.

Phenological data collected by the author from several locations in Honduras indicate that the fruit is produced twice a year, with the first seedfall occurring

in May through June and the second in November through December. Coyol becomes ripe at the end of the second dry season when food sources are most limited in this region. Accordingly, it would have been an excellent famine food—a feature that surely must have enhanced its value.

To determine the productivity of coyol, three fields were selected to represent a range of coyol density where they were not cultivated or planted, but allowed to grow as volunteers. The first plot, a pasture at the Centro Nacional de Granaderia de Comayagua, Honduras, appeared sparsely populated with coyol (Table 3). The second plot, a cornfield at the Centro, showed medium coyol density. Both plots were located on an alluvial terrace at about the same elevation (600 m) as the floor of the Copán Valley. The third plot was a fallow field in the Copán Pocket on a moderate slope in the Rio Gila drainage. This represents an area with high coyol density. The palms in each plot were counted and the fruiting inflorescences from two trees in each plot were harvested (Table 4).

TABLE 3.—*A. mexicana trees per hectare (ha) from three Honduran fields. The first two plots were in the Comayagua Valley and the third was in the Gila Valley of the Copan Pocket.*

Field	Area (ha)	Total Trees	Trees in Fruit	Fruiting Trees/ha
1	0.8	4	3	3.8
2	2	14	8	4
3	1.75	46	24	13.7
				Avg. = 7.7

A nutritional analysis of coyol mesocarps and kernels was conducted on mature fruits taken from the Copán Valley (Table 5). The fruits have high caloric contents: 6,600 calories/kg for the kernel and 5,610 calories/kg for the mesocarp. This compares very favorably to other foods, such as maize which produces 3,610 calories/kg (Webster 1981:920). The high fat content of coyol is responsible for the prodigious caloric value. Protein, at least from the kernel, is also in good supply at 14.62% by weight.

When these data are combined, an estimate, albeit a rough one, of coyol productivity can be derived. An average coyol palm will produce 493 fruits/tree (Table 4), or, given that two harvests per year can be obtained, 986 fruits/tree/year. If data from Table 5 are included, an average tree can be shown to produce 5.57 kg/tree/year of edible fruit. We can multiply the amount of land suitable for coyol (4490 ha) times the average number of trees per hectare (7.7) times the average number of fruits per year per tree (986) and a result of over 34 million fruits per year is obtained. Going back to Table 5 to enter the number of calories per fruit (32.34), we can calculate the number of calories per year for coyol (total = approximately 1.1 billion calories/year). These figures are based on

TABLE 4.—*A. mexicana fruit production per tree. Trees number 1 and 2 were from the first Comayagua Valley field, 3 and 4 were from the second Comayagua Valley field and 5 and 6 were from the Copán Pocket.*

Tree	# Inflorescences	# Fruits
1	5	660
2	2	842
3	2	464
4	1	329
5	2	276
6	3	386
Total	15	2,957
Average/tree	2.5	493
Average/tree/year	—	986
kg edible fruit/tree/year	5.57	

TABLE 5.—*Nutritional data for A. mexicana kernels and mesocarps. Being of doubtful food value, the other tissue layers of A. mexicana fruits, i.e., the endocarp and the pericarp, were not analyzed.*

Component	Kernel	Mesocarp
Avg. wt./fruit (air dried), g	0.65	5.00
Protein, %	14.62	3.29
Fats, %	44.28	34.92
Carbohydrates, %	18.86	40.21
Fiber, %	14.59	8.26
Ash, %	2.88	3.69
Water, %	4.77	9.63
Calcium, mg/g	0.08	1.05
Phosphorus, mg/g	0.03	0.16
calories/g	6.60	5.61
calories/fruit	4.29	28.05
Total calories/fruit	32.34	

current usage practices where coyol is merely allowed to grow when it volunteers and is not actively cultivated.

At its hypothesized maximum, 20,000 people lived in the Copán Pocket during the Coner phase (Sanders 1989). If 2,200 calories (see Dickson 1980:704) are required per person per day, then 16.06 billion calories would have been required annually to sustain the Copán population at its peak. Accordingly, coyol could have supplied about 7% of the calories needed during the high point in the demographic trend of the Coner phase and even more if the palms were actively planted and cultivated. Furthermore, this production could have been achieved with relatively little impact on the corn or other major crop harvests.

Coyol fits very well into the infield/outfield agricultural model described by Netting (1977) and Flannery (1982). The outfields are large extensive plots planted away from the habitation site, usually in monoculture with a grain, in this case corn, as the principal crop. The outfields are managed with relatively low labor input per unit area and are used on a cyclical basis with planting episodes following fallow periods. Slash-and-burn techniques can be used to prepare the fields while variations on the main theme, such as intercropping (more than one crop in a field at the same time) and multicropping (different crops in the same field at different times) can also be employed.

Infields are located adjacent to the house compound and managed intensively with a variety of fruit trees and garden crops being the main producers. It is possible for these small plots to have been utilized year in and year out, but kept fertile with household refuse. In the outfields, coyol may have been treated just as the modern Mestizos do today by cutting around it when they clear the fields and allowing it to grow after it volunteers. In the infields, coyol could have been planted just as the Jicaque do to provide a source of fruit next to the houses. Another fruit-bearing tree, ramon (*Brosimum alicastrum* Sw.), has been proposed (Puleston 1982) for this anthropogenic niche in prehistoric times, but as yet, little archaeobotanical evidence has been found to corroborate this assertion.

Since coyol sap can be used to make wine, perhaps the early Maya were interested in the more stimulating products of this economic species. "Balche," an intoxicating beverage made from a mixture of *Lonchocarpus longistylus* Pittier bark and honey was consumed by the Maya as a ceremoial beverage (Roys 1931: 216). Possibly coyol wine was used in a similar fashion. It is conceivable that the Maya brought in coyol for wine-making, then made greater use of the fruits as demands on local resources increased.

Perhaps the most important feature of coyol is the high fat content of the fruits. Today, most Central Americans use the fat of domesticated animals for their cooking needs. This was not available in pre-Columbian times and there were not many options in terms of oil sources. Moreover, it seems reasonable to suggest that coyol fit into the dietary pattern as a dependable source of fat and/or cooking oil.

In the case of the Copán Maya, populations in the valley seem to have grown considerably during the Coner Phase. According to general productivity estimates (Sanders 1989), the population of 20,000 at its zenith would have exceeded the carrying capacity of the valley, even if all of the available arable land had been brought under cultivation. In such a situation, expanding the use of coyol and other weedy, but edible plants would have been a way, at least temporarily, to

increase yields when traditional cultigen production employing slash-and-burn techniques had already been maximized.

CONCLUSIONS

A. mexicana was used and distributed by prehistoric Native Americans from Mexico to Panama. Its high fat content probably made coyol attractive as a source of cooking oil, although its value as fresh fruit or as a source of wine could have been exploited, too. Coyol may well have been cultivated in prehistoric times and it undoubtedly assumed a larger role during times of famine or when populations exceeded carrying capacities, as with the Late Classic Maya of Copan.

NOTE

[1]At least three species of *Acrocomia* have been described for Central America and Mexico: *A. mexicana, A. vinifera* Oerst. and *A. belizensis* Bailey. However, the taxonomic boundaries among these species are not clearly defined such that these taxa are indistinguishable to many botanists and may represent synonyms for the same plant (Standley 1937; Standley and Steyermark 1946; Williams 1981). For the purposes of this article, they will all be treated as *A. mexicana*.

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This is an impressive and valuable volume which promises to be the standard reference work on its subject for many years to come. The book covers the medicinal, hallucinogenic, and poisonous plants of eastern Ecuador, northeastern Peru, southeastern Colombia, northwestern Brazil, and the southern tip of Venezuela. It contains taxonomic, ethnobotanical, and pharmacological information on 1516 species used by native peoples of the area. Many plants are represented by photographs or line drawings. The book is extremely authoritative and well-referenced.

The book does have a few minor limitations. No descriptions of the plants are given, only references to the original technical diagnoses. These are often scanty and sometimes difficult to obtain. Perhaps references to more recent taxonomic monographs would have been more useful. An index to the innumerable native names given in the work would also have been helpful. The discussions of uses and pharmacological properties is very uneven, but this reflects our present state of knowledge.

This book will be extremely useful to pharmacologists seeking new sources of pharmaceuticals. The sheer magnitude of the work, covering one small corner of the tropics, and its explicit acknowledgment of its own incompleteness, should help those seeking to publicize the importance of preventing the destruction of the world's rainforests.

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PIG LOVERS AND PIG HATERS: PATTERNS OF PALESTINIAN PORK PRODUCTION

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ABSTRACT.—The Biblical injunction against the pig makes the discovery of remains of this animal on Near Eastern archaeological sites singularly worthy of comment. Various explanations for the origins of the food taboo have made use of sketchy and anecdotal evidence of ancient Palestinian pig exploitation. This more organized review of the available pig bone evidence suggests that the pattern of pork consumption is tied to a complex web of environmental, political and agricultural factors, forces whose individual explanatory power varies with the historical period examined. Thus, if behavior shaped the institution of the Biblical food rules, it will first be necessary to determine the period when the rules became part of the transmitted tradition before the material factors affecting that legislation can be isolated.

RESUMEN.—La prohibición bíblica contra el cerdo hace singularmente digno de comentario el hallazgo de los restos de este animal en sitios arqueológicos del Cercano Oriente. Las diferentes explicaciones del origen de estes tabus alimenticios han empleado evidencia incompleta y anecdótica de la explotación de cerdos en Palestina antigua. Esta vista mas organizada de la evidencia disponsible sobre huesos porcinos sugiere que el patrón de consumo de carne de marrano se relaciona a une red compleja de factores ambientales, políticos, y aghrarias. El poder explicativo de estas fuerzas varía según el período histórico estudiado. Por lo tanto, si el comportamiento diera forma al establecimiento de las reglas alimenticias bíblicas, será necesario averiguar primero cuando el reglamento se hizo parte de la traición trasmitida antes de que se puedan aislar los factores que afectaron esa legislación.

RESUME.—La prohibition biblique contre le cochon rend notable la découverte des restes de cet animal dans les sites archéologiques de l'Orient Proche. Les explications differentes pour l'origine de ce tabou alimentaire ont usé l'évidence incomplète et anecdotique pour l'exploitation ancienne du cochon palestinien. Ce sommaire plus organizé de l'évidence disponsible chez les os du cochon suggère que cette modèle pour la consumption du porc s'est liée a une toile complèxe des facteurs environnementals, politiques, et agricoles. Le pouvoir explicatif de ces facteurs change avec la periode historique examinée. Donc, si la conduite a formé l'establissement des règles bibliques de l'alimentation, on doit premièrement determiner l'époque quand les règles se sont devenus une partie le la tradition transmise avant d'isoler les facteurs materiels qui ont affecté a cette législation.

DEDICATION

The departments of anthropology at the University of Alabama and the University of Alabama at Birmingham conduct a unique cooperative graduate program. Many bureaucrats were openly skeptical when the idea to expand the University of Alabama's program to include the faculty and students at Birmingham was first broached. They were not without evidence. Many proposed joint campus ventures had sunk without a trace over the years; parochialism could have killed this one as well. However, their prediction did not consider the power of inter-faculty cooperation. To forge the spirit of trust that makes cooperative programs work, Earle Smith, in both his roles as a senior member of the faculty and head of the department at the University of Alabama, worked tirelessly to build bridges between our campuses. One of the ways he achieved results stimulates this paper. Annually our departments gather to discuss the program. Often these events have been held at Moundville, Alabama's impressive archaeological site and public park. Faculty attendance was never a problem since these were opportunities to sample and savor Earle's pork barbecue as well as discuss academic issues. Differences of opinion seemed to waft away as the smells from the grill drifted into the conference room. An important basic social rule applied: shared food reinforced shared interests. Earle's success stands in sharp contrast to the following discussion of pigs and people, where food is an institution that often keeps people apart.

INTRODUCTION

The discovery of pig remains in historic period excavations in Palestine inevitably inspires comment. These treatments are, more often than not, devoted to explaining why the bones are intrusive or otherwise not associated with the period, place and people under investigation. From a simple materialist point of view, it is not obvious why this should be. The pig, wild and domestic, has been an indigenous part of the wildlife of the Middle East for millennia. Moreover, the hog is recognized worldwide as a productive resource, since it couples rapid rates of growth and reproduction with a tractable nature into a suitable package for both small and large scale husbandry. Thus it would be fair to predict that the discovery of the remains of this creature in archaeological sites in Palestine should excite little interest outside the circle of animal bone specialists. But, of course, the pig's productive potential is not the whole story. We are also aware of the texts and traditions which demand that the pig be avoided by two of the three major religious communities of the region. The existence of these food rules, dietary restrictions that seem at least arbitrary and perhaps counterproductive to observers in Europe and America who are outside these faiths, has stimulated a vast literature concerned with the origins and meaning of pig avoidance.

Pig bones, as they have been encountered in various excavations, have been used as historical ammunition in many of these discussions of the food rules. Probably because bones were not routinely collected by archaeologists until recently (Dever 1983, note 9, p. 582), much of this interpretation of the meaning

of pig remains in the animal bone record of Palestine has been unsystematic. Most importantly, estimations of past patterns of boar hunting, hog husbandry or pig sacrifice have not been linked to an understanding of ancient animal husbandry systems as wholes. Recent work has begun to change this. A number of sites now have been sampled more or less intensively for bones. Data from these excavations can be used to sketch an outline of the history of pig use in Palestine. It is now reasonable to ask whether the regional patterns that we are beginning to discern are any help in understanding the origins of the food traditions and prohibitions.

PIG THEORIES

The reasons that the pig is prohibited for Muslims and Jews have been the source of debate for centuries (for instance, see the survey in Hunn 1979). In addition to those models which specifically invoke unverifiable religious forces as explanation for the rules of pig avoidance or offer allegorical accounts, there are other propositions which incorporate such cultural factors as ideology, ethnicity, and economic behavior together with environmental factors into models potentially testable with archaeological data. The explanations fall into two broad clusters—(1) Cultural Historical: those which depend on the ideological or ethnic identification of the prohibitors, and, (2) Cultural Ecological: those which do not, suggesting rather that the Palestinian examples of pig taboo are special cases of broader ecological or political processes. Within the clusters, each type of explanation has a different potential relationship to the archaeological record. Briefly summarized these are some of the alternatives:

(1) *Ethnic/Political.*—A culture's identity is interwoven with its foodways (Bökönyi 1975, Reitz and Honerkamp 1983). Insofar as one society disdains an adjacent group, it will choose not to emulate that neighbor's cuisine. Frederick Zeuner (1963:261), for instance, enthusiastically refers to Antonius's explanation of the Israelite taboo when he writes, "[A]s the pig is valuable to the settled farmer only, the nomads, who have always felt superior to the farmer, came to despise the pig as well as the farmer who bred it. In due course, they developed religious prohibitions against the animal they themselves could neither breed or keep."

The pig principle of Antonius can be applied directly to the behavior of Israelites in Canaan if one is willing to accept one of the widely accepted models of Israelite settlement, that this Late Bronze Age–Early Iron Age[1] event was a process of sedentarization of former nomads [see Finkelstein's (1988a, 1988b) and Fritz's (1987) recent elaborations of this theory]. Given the additional assumption that foodways are conservative cultural features that would survive the sedentarization process, the archaeological implications are clear: pigless garbage might be the detritus of Israelites, pork bones certainly mean the Philistines (amongst others).

But nomadic roots for the Israelites are not universally accepted. Other authorities review models where the "proto–Israelites" were actually settled Canaanites or migrating, in the sense of a one–time movement, rather than nomadic, invaders see, for instance, the discussions of Aharoni (1982), Gottwald (1979),

Lemche (1985), Yadin (1979), Yurco (1990). If one of these hypothesized historical processes turns out to be true, and nomadic proto–Israelites are rejected, one can salvage the principle of ethnic disdain by generalizing to a suggestion that pigs and pig products were the purview of some social class or sector within Canaanite society. Also, political fragmentation and subsequent resettlement in a new ethnic geography could generate cuisine disdain as peoples suddenly discover they have new and different neighbors (I am reminded of the Assyrian policy of extensive community relocation, one they applied during their region–wide domination during the later part of the Iron Age.[2]) Using either argument, it is easy to move to the archaeological proposition that pigs will be absent from the garbage of prohibiting ethnic communities and present in that of their enemies. The distribution of pig bones will be found to be a ''map'' of political relations between groups with different subsistence traditions. Of course the problem now becomes one of explaining how sharply divergent subsistence traditions can emerge in similar environments.

Success in applying this model to the excavated record in a more than perfectly circular manner requires an ability to identify not only the ethnicity of architecture and ceramics but also communal garbage pits as well, a problem likely to be very difficult in large complex multi–ethnic communities. Further, the date when the two cultures and cuisines came into contact must be specified to evaluate the proposal as an explanation of origins. As an archaeological problem, however, this explanation has the distinct advantage of requiring a positive pattern. Since pig disdain is seen as a response to pig love, analysis needs to discover places where pork production was embraced so as to provide the stimulus for the vocal disgust of the prohibitors.

(1) *Ethnic/Religious.*—De Vaux provides an alternative—and more familiar—process for the development of the taboo, one that is rooted in religion. He concludes from his survey of prehistoric and historic pig related behavior that the Biblical expression of revulsion for the pig derived from much more ancient divisions in Canaanite cultic practice,

> The most likely answer is that the prohibition is pre–Israelite in origin and that it was preserved in Israel after its religious origins were forgotten. After all, Jews and Muslims of today abstain from eating pork without knowing why, except that it is forbidden by the Torah and by the Koran. And it is quite possible that this revulsion for the pig, which became second nature to the Israelites, was reinforced by the ritual usage which they saw made of it in certain pagan rites.
>
> (de Vaux 1972:267)

In this case the archaeological challenge is to identify the 'ritual' use of pigs by the Israelites' neighbors and antecedents. This would provide evidence for a practice which could have been abhored by some during the Bronze Age, making it a source for a tradition that later was transmitted to the Bible where we see them in the Levitical and Deuteronomic documents in texts which achieved the form we have the today only centuries later. As will be discussed, some of the

suggested evidence for 'cultic pigs' founders on the shoals of animal bone identification.

(1) *Symbolic/Linguistic.*—Douglas (1966) argued that the pig is prohibited because of the anomalous position it holds within the structure of animal classification reflected in the Bible and the relationship taxonomic anomaly has to the basic concepts of purity central to the Israelite ideology. The pig is only one of many potentially defiling animals. It is singled out for special mention not because it is more defiling than other forbidden animals, but because of the possibility of classificatory confusion. From an archaeological point of view this is a variant on the Ethnic/Political explanation (see above). For archaeological evaluation it shares the same problems of determining ethnic identity in the excavation record. On the other hand it has the advantage of greatly expanding the list of species whose distribution should be similar to that of the pig—animals such as the hare, camel, hyrax, donkey, and all the carnivores. However, since the origins of the taboo are found to be within a culture rather than a byproduct of its external relations, a different approach to predicting its archaeological appearance is necessary. The additional requirement is that the linguistic process which evolved the pig's (and other animals) anomalous position within the classification and the ideological web within which it fits is sufficiently well understood historically to predict when an emerging set of food prohibitions might have had behavioral consequences.

(2) *Environment.*—Because of the particular requirements demanded by the physiology and behavior of pigs, these animals are missing from the larders of those who occupy hot, dry climates and from the herds of those whose lifestyle is migratory or nomadic (Harris 1974, 1985). Given what is known about climatic change and past environment, the ecological model produces specific expectations about the potential distribution of pork production. Foodways, once established, are viewed as highly conservative cultural features. Following the same line of argument as Antonius, Harris (1985) also suggests that those communities with food traditions forged in arid climes might find political reason to continue these foodways even after entering well–watered habitats. Though Harris does not mention it, one can also suggest that the foodways of immigrants from pig loving lands would also be maintained as a tradition in the new home. This might appear as an extra emphasis on pork production in regions where pig raising is minimally practicable.

(2) *Initial Settlement.*—This last point can be generalized by placing it in the context of overall pastoral management. The productive capacity of pigs make them ideal initial barnyard stock for settlers establishing themselves in a new land. Crabtree (1989:210) illustrates this point with the evidence from Anglo–Saxon West Stow:

> One of the main problems that . . . settlers would have faced was establishing their herds of domestic animals. Since pigs mature quickly and multiply rapdily, they are ideal animals for colonizers. A somewhat higher reliance on pigs in the early 5th century may have allowed the

> West Stow farmers to build their herds more rapidly. Once adequate stock levels had been established, the early Anglo–Saxon settlers would have shifted their attention away from pigs and increased the numbers of cattle and sheep . . .

The archaeological application of this principle will require finely stratified samples. Practically speaking for tell sites such as are common in Palestine, the advent of pig use will be clearly identifiable, its abandonment less so as the processes of redeposition have usually taphonomically transformed the samples (Hesse and Rosen 1988).

(2) *Hygenic.*—Many authors have considered the possibility that the taboo was related to the pig's potential role as a vector for disease, usually trichinosis. Although difficulties with this proposition have been dealt with by Harris (1974), it is interesting to note the discovery of a *Trichinella* cyst in a ca. 20th Dynasty mummy (Hecker 1982, citing Millet *et al.* 1980).

(2) *Agricultural.*—A central problem of husbandry is balancing the needs of the animals with those of agriculture. Feed must be provided either through shifting potential cropland to pastureland or through the processing of agricultural byproducts. As agriculture intensifies, the first option becomes less attractive. Pork production, however, will continue to flourish as long as the crops selected are those which produce abundances of plant refuse. However, as those crops (basically the grains) are replaced by those with smaller refuse fractions, pork production becomes marginally less efficient compared to the husbanding of other animals such as sheep and goats at a distance, in pastures inaccessible to pigs either because of the difficulty in herding large numbers of them or the quality of the terrain. This economic reality may underlie Coon's (1958) suggestion that an emphasis on olive and vine production will depress pork production [see the discussion of agricultural byproducts in Preston *et al.* (1985) and Sansoucy (1985)]. Since Palestinian agricultural production evolved and specialized in those directions with geographically diversified emphases (Stager 1985), we may hypothesize that animal husbandries responded to the changes in a like manner.

(2) *Political.*—In complex societies animal production takes place within the context of a market or other complex redistribution system. These institutions are likely to attract the attention of central administrations as a source of revenue. Pigs and pork are a poor choice for fulfilling the taxation needs of these governmental bodies because the animals produce few secondary products and the primary product is difficult to store. The spoilage potential of pork is probably overstated since procedures outlined in *De agricultura* by Cato (234–149 BC) in section CLXII, 1–3, indicate the antiquity of ham curing in the Mediterranean world. It would be useful to know when the technique was first known in the Levant.

Diener and Robkin (1978) argue that pigs are the domestic animal of choice of small (often rural) householders, selected in an attempt to achieve a degree in independence from the onerous demands of ruling elites [see also Coon (1958)].

Governments seek to discourage these pigsties and their informal marketing arrangements by establishing regulations and by appealing to widely held ideals. The ethnographic work of Kluck (1983:143) illustrates how this works in Brazil where:

> The sale of lard and sausage is supposed to be taxed and subject to rigorous licensing—so rigorous as to prohibit *de facto* their sale. The stated rationale for such a policy is hygenic. This concern for public health varies seasonally, however. Its implementation is most rigorous in November–December when the municipal government is most severely strapped for funds . . . Farmers in towns lacking meat packing plants do not face similar restrictions. The policy has therefore created a flourishing *sub rosa* trade in the sale of sausage and lard . . . The ways they have devised for avoiding the government agents attempting to enforce this policy are legion, and the nature of sausage and lard allows them more room to maneuver than would milk.''

There are several important implications of this theory for Palestine in the historic periods. The first being that pig production would tend to be stifled in times of powerful central administration and more widespread during periods of the exercise of local power. Second, in all periods when pig husbandry is present at all, it should have been more common in the rural sectors. This is because small producers would likely have attempted to avoid total engulfment in the centralized economy by shaping their household husbandry to emphasize the consumable (commodity) value of animals rather than their use as items of exchange (currency) in a taxation and market system. Third, justification for the anti–pig policies is likely to have been couched in sacred terms where the validity of the government was interwoven with religious values. The rate of pig consumption thus becomes an indirect index of the involvement of central governments and others interested in maximizing tax offtake from local producers in local subsistence systems.

With this review of pig theories in hand, the purpose of the remainder of this paper is to survey the archaeological evidence for pig exploitation in the Levant and identify the patterns associated with various periods. This information can then be employed to evaluate some of the proposed explanations for the distribution of pig use and abuse in Palestine.

THE NEAR EASTERN PIG

The pig has a long history of habitation in the Levant. In Tchernov's survey of Quaternary fauna he notes the presence of the Villafranchian pig *Sus strozzi* (Kurten 1968:154–155) in Preglacial Pleistocene levels in the Bethlehem conglomerate (Tchernov 1979:261). The earliest record of the modern species of pig *Sus scrofa* is recorded from Benot Ya'akov in Middle Acheulean levels (Tchernov 1979:264) and in a host of later Pleistocene deposits (Tchernov 1979:267–269) including Tabun and Hayonim.

Taxonomy and Distribution.—Modern wild pigs have been surveyed by Harrison (1968) and Groves (1981). They identify two subspecies of distinctive appearance, *Sus scrofa attila* Thomas, 1912, and *Sus scrofa libycus* Gray, 1868, for the Middle East. The first and larger of the forms is found in Iraq, Iran, and regions to the north of the Black, Caspian, and Aral seas. The latter ranges south from Anatolia and Syria (Groves 1981:28, Fig. 6.),

> "into Israel, where Tristam said that it used to swarm in all thickets by the Jordan and the Dead Sea, extending even to the bare wilderness of Judaea. He also noted it from the Waters of Merom: Mt. Tabor: Carmel; Rr. Kishon; Sharon Plain; Wadi Arnon and Jabbok. Bodenheimer said that it still occurs in Upper Galilee, especially in the Hula thickets and in the Araba and that it had disappeared in the coastal plain where it had been noted at Petah Tikvah, near Jaffa as well as at Rass el Ein and in Jordan from Wadi Hanna near Nablus; Salfit mountains; Fallik; Shooni T-J and Jisr Damia Bridge. Hart saw them near Beersheba and found them abundant in the northern Negev between the Ghor and Gaza."
>
> (Harrison 1968:375, his references omitted)

Groves (1981:28) identifies the wild pig population of the Nile Delta with this second subspecies as well. Uerpmann's (1987:42) review of the archaeological record of wild boar in the Middle East reinforces these observations: "Although highly adaptive to many different biotypes, the wild boar is not an animal of the arid deserts. It was and is present along the Euphrates valley, but there is no indication that it penetrated deeply into the Arabian Peninsula. Most of the sites on the eastern slopes of the Levantine mountains have not yielded any *Sus* remains, nor were pigs identified at the sites in eastern Arabia."

It is clear from this geographic survey that wild pigs occupied most of the regions of the Levant, including dry and rough terrain not usually associated with the species, even though they favor dense thickets and marshes along permanent water courses. Some populations move into hill slope woods during the winter season (Harrison 1968:375). Based on descriptions of Iraqi boar behavior they are agricultural pests, doing great damage to crops, particularly cereals, during night raids (Harrison 1968:375).

Domestication and Osteometry.—Of the three subspecies of *Sus scrofa*, *S. s. scrofa*, the European wild boar, is the smallest, *S. s. libycus* is intermediate, and *S. s. attila* the largest. The relative sizes of the various subspecies of pigs are important to this discussion because the primary method used to determine archaeologically the domestic or wild status of the pig from isolated bone fragments is size. Husbanded animals are smaller and show some degree of facial shortening compared to wild examples, a trait often marked additionally by the absence of a premolar.

Flannery (1983:169, Table 3) has published a list of measurements of Near Eastern pigs. Within this list there is a great deal of overlap between the thirteen skeletons from Iran and Iraq and the eight from Syria and Israel. However, though the difference may result from chance in such small samples, the arithmetic means

of specific measurements taken on the two groups of pigs are different. For example, considering the length of the lower third molar, the average is 41.62mm, SD=2.8 for 13 specimens in the first group and 39.38, SD=4.6 for the second. If these differences are repeated in larger samples, it will be important to be clear which wild standard is employed in determining the wild/domestic status of a particular archaeological specimen in order to establish a conservative decision point. Further, the effects of age-related change and sexual dimorphism on the interpretation of measurement distributions complicates the issue (Payne and Bull 1988). Given the smaller size of the wild population in the Levant, reasonable measurement ranges for wild Levantine suids should lie somewhere between those given by Flannery (1983:170) for the whole Near East and those suggested by Boessneck *et al.* (1963) for European pigs.

The successful application of these measurement criteria to particular archaeological questions assumes that the wild populations are flourishing in typical habitat and remain isolated from domestic stock. Groves (1981:41, Note 4, his reference omitted) points out that, "[D]omestic pigs can remain healthy and fertile on a diet which stunts their growth almost beyond belief. If the same applies to wild pigs, then crowding and sub-optimal diet on small islands could explain small size without any change in gene pool . . ." If the scattered pockets of 'good pig country' near the limits of the distribution of the pig in the Near East acted like islands, or the smaller populations in the southern Levant experienced much gene inflow from feral individuals, both reasonable possibilities, then there is a real possibility of the presence of wild populations of smaller animals, creatures available to be taken by hunters on an occasional basis. Nurkin (n.d.) has illustrated this point. He measured a sample of wild pigs from Sedom in the Tel Aviv University collections. The range of lengths of the lower third molar he found was 28.5–40.6 mm with a mean = 36.2 mm and SD = 3.6, values well below both the southwest Asian average (both subspecies) and the subset of what were probably *Sus scrofa libycus* suggested by Flannery. Thus, at the limits of the distribution of the wild pig in Palestine and when the specimens are few, relying solely on osteometrics to determine the domestic status of swine in archaeological remains can be risky. For this reason verification usually demands the discovery of pig related artifacts [such as pens (Hecker 1984)] or evidence that the pig cull matches the practice of swineherds rather than the take of boar hunters, i.e., an abundance of young in the slaughter (see the cautionary notes of Lauwerier 1983).

Unfortunately the published record for pig bones in Palestine is spotty with respect to these three attributes—osteometry, mortality, and artifacts of husbandry. In the archaeological review that follows, only rarely will I be able to identify with certainty the domestic or wild status of the exploited pigs.

Requirements of Domestic Swine.—No better description of the basic needs of domestic pigs can be found than that provided by Columella (*Res rustica* VII, 6–8),

> Moreover, pigs can make shift in any sort of country wherever situated. For they find suitable pasture both in the mountains and in the plains, though it is better on marshy ground than on dry. The most convenient feeding-grounds are woods . . . For these ripen at different times

> and provide plenty of food for the herd almost all the year round. But where there is a lack of trees, we shall have recourse to fodder which grown near the ground and prefer muddy to dry ground, so that the pigs may root about in the marsh . . . Sows indeed grow fat on cultivated ground when it is grassy and planted with fruit-trees of several kinds . . . You should not . . . be sparing of the contents of the granary, which should often be handed out when out-door food fails.

Successful swineherding is associated with rainfall or moist ground, the presence of mixed deciduous forest, and the availability of reserve fodder collected from agricultural activities. It is thus clear that evaluating the potential for pork production in various parts of Palestine will require a knowledge of the history of local environmental conditions and crop choices, a subject just beginning to be broadly undertaken.

THE NATURE OF ARCHAEOLOGICAL PIG SAMPLES

Significance.—Before turning to an examination of the Palestinian pig bone record, some attention must be given to the methods of determining what is a "significant" datum. The foregoing résumé of wild pig geography makes it clear that pigs were a potential part of the diet almost anywhere in the Levant. It is also true that non-human agents, dogs and other scavengers for example, are responsible for some of the accumulations found at archaeological sites. Thus, any measurement of the importance of the pig in some period or at some place within Palestinian archaeology is a mixture of context evaluation and quantitative technique directed toward the two questions: (1) Does a sample have enough pig bones to make it significant?, and (2) Were bones found in a context that draws attention?

The most obvious was to tackle pig "significance" with archaeological remains is by looking for pig abundance, this on the theory that the level of contribution to the economy will be mirrored in the ideology. However, a cautionary note should be sounded. Consider Shanklin's (1983:11) review of goats among the Kom of Cameroon:

> Goats are "valuable" in that their monetary worth is considerable, but, unlike the cattle kept by Fulani pastoralists in the area, for example, goats are not "valued" or held in high esteem. In a culture in which several animals are esteemed for their "intrinsic" merits . . . there are no representations of goats (or chickens), no folk tales or proverbs that deal with or even mention them . . . There are two kinds of goats, said one informant, goats and sheep. Sheep have certain magical characteristics but goats have none.

In the absence of a textual setting, nevertheless, considerations of abundance may be the only possible approach, and certainly it is one that should not be cast out of hand.

Regional Perspectives.—The subsistence systems of the Levant were and are diverse (Hopkins 1985). Depending on the local environment, a varying mixture of village based agro-pastoralists and nomadic pastoralists can be expected. Each end of this continuum is associated with different animal management mixes. One classification relevant here was developed by Grigson (1987:232) in her study of the Negev Chalcolithic. She has defined two strategies—one, tied to the possibility of rain fed agriculture mixes sheep, goats, cattle and pigs in the barnyard; the other, located in more arid climes where some form of irrigation is necessary, drops the pig from the herd list. This dichotomy is important for it points out that adjacent communities in complex landscapes may practice divergent husbandry practices (Flannery 1983:183) and that it will require samples from a regional array of sites to establish a subsistence pattern.

Sampling Complex Distributions.—The individual activities which make up the process of animal exploitation are spatially segregated. Animals are pastured or foddered in one location; milked, shorn, or worked in another; slaughtered in a third; butchered in yet a fourth; prepared into meals in a fifth; have their bodies turned into tools in a sixth; and finally have the debris of all this processing activity scattered across the various dumps of the community. For pig remains in Palestine, the parade case of this kind of bias is the famous pig from Hazor (Angress 1956). The skeleton of this much noted find is represented only by head and trunk, the limbs from the carcass having been transported and deposited elsewhere.

Additionally, different sectors of complex societies have variable access to the numerous resources provided by all this processing (Wapnish *et al.* 1977, Zeder 1988). A community with significant economic specialization and stratification has as a result a complex deposition of faunal remains. Particularly in multi-period sites, a random sample of social complexity in the collected bone remains is extremely difficult to achieve, even if that is a primary goal of excavation. Thus a serious problem facing the interpretation of all faunal remains from complex sites is determining how representative of an entire community the collection of bones under study is. For instance, Hecker (1982) has argued that pork may have been the food of the lower socio-economic strata of ancient Egyptian society during some periods. If that rule or some variant of it applies, it is likely that a quantitative estimate of abundance for pork expressed for a whole site (e.g. 20% pig at Site A in Period A) will at best only faintly represent much more important within site variability.

The activities which surround different areas of sites also bias the way bones are deposited. For instance Horwitz (1987) has observed that while pig remains are found in early second millenium BC 'Emeq Refaim domestic areas, they are absent from the associated tombs at Givat Masu'a [the specific period is labeled by various authors as Early Bronze IV, Middle Bronze I or Intermediate Bronze].

A number of methods have evolved to deal with these problems of inter- and intra-site variability which bias comparisons of species relative abundance (Hesse and Wapnish 1985). All are quantitative evaluations of bone element counts (or transformations of those counts) placed in comparison to the postulated

effects of hypothesized biasing factors [see, for example, the segregation of the debris associated with slaughter from that of butchering suggested by Hellwing and Gophna (1984). For the purposes of this review, the caution the examples provide is more important. Samples of pig bones from Palestinian archaeological sites large enough to bear such analysis have been found only infrequently. It is even rarer to find zooarchaeological samples published in a way that biases of this sort can be detected. I will usually have to rely on simple abundance statistics which purport to represent whole sites and periods, and hope for the best.

ARCHAEOLOGICAL PATTERNS IN PIG PRODUCTION

My following discussion of the pig remains in archaeological sites is largely limited to Cisjordan so as to focus on the use of swine in the immediate environment of Canaan. Additionally the review is restricted to the latest prehistoric periods and the Bronze and Iron Ages, a span from about 4500 to 500 BC. Almost all estimates of abundance offered here are percentages of the total number of identifiable bone fragments in a sample which came from pigs (variously abbreviated in the literature E, TNF, or NISP). A few are expressed with the relative frequency statistic (RF). This estimator attempts to correct for some of the inherent biases of TNF (Hesse and Wapnish 1985). RF is closely correlated with TNF and both avoid the bias of the statistic Minimum Number of Individuals, which tends to overestimate the abundance of rare taxa. Given the variability in samples collected by a host of excavation teams over many years, the values for pig abundance tabulated here should be taken only as rough estimates of actual levels of exploitation.

Chalcolithic and Early Bronze Age—ca. 4500-2000 BC.—The argument that the importance of boar hunting and swine herding is closely related to the distribution of rainfall and suitable terrain is corroborated in the scatter of samples that are available from the Chalcolithic (Table 1, Fig. 1). A number of sites of this period in southern Canaan have no pig bones at all reported: Horvat Beter (Angress 1959), Bir es Safadi (Josien 1955), Bir Abou Matar (Josien 1955) and Shiqmim (Grigson 1987). However, Ducos (1968) has described five locales with abundant pig remains: Tel Aviv (Jabotinsky Road), Metzger, Wadi Gaza, Gat Govrin, and Munhatta. Gilat is another pig-rich site in the Chalcolithic—a deposit that assayed 18% pig (Grigson 1987:235, Table 7-2).

Grigson (1987:231) argues that the distribution of Chalcolithic pig use corresponds to the probable ancient location of the 300 mm isohyet. This precipitation line effectively divides the Negev into those areas where sedentary rainfall agriculture is possible and those where migratory pastoralism coupled with seasonal agriculture based on simple water control was necessary.

Although animal remains have been reported from only a few Early Bronze Age sites (Table 1, Fig. 1), they come from most of the region. Some of the variability is linked to the distribution of ideal pig habitats. For instance Horwitz (1985) reports that the sample from En Shadud contained 24% pig. This site is located in the Jezreel, the great fertile valley that forms the southern boundary of the

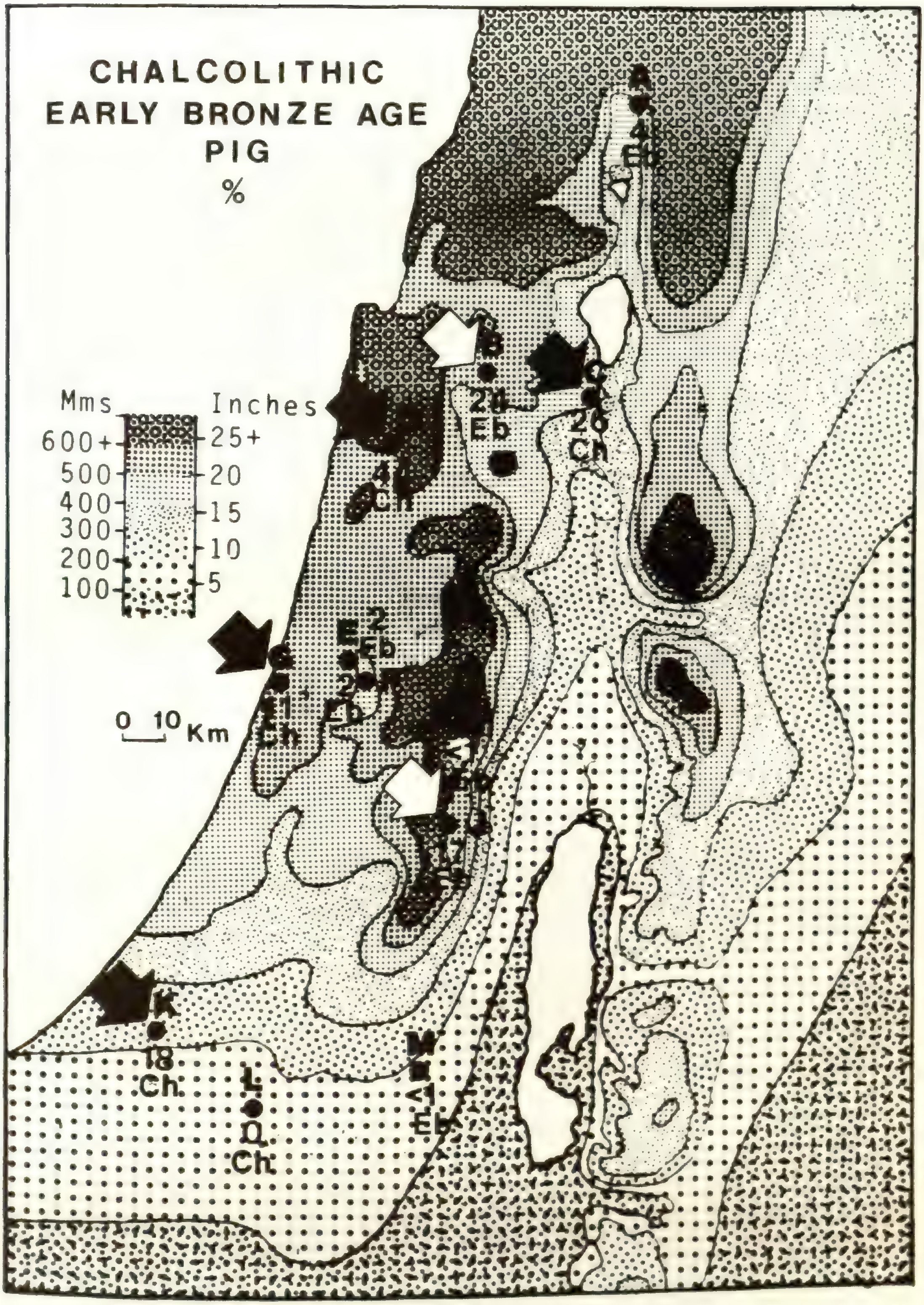

FIG. 1. Chalcolithic and Early Bronze Age Pig Abundance. All maps were prepared by Nancy Carney-Barnhart and Lester Barnhart. A. Dan, B. En Shadud, C. Manhatta, D. Metzger, E. Aphek, F. Dalit, G. Tel Aviv, H. Ai, J. Refaim, K. Gilat, L. Shiqmim, M. Arad.

TABLE 1. *Chalcolithic and Early Bronze Age Pig Remains. (4500-2000 BC).*

In almost all cases the abundance of pig is estimated by the total number of fragments assigned to this taxon (variously abbreciated E, NISP, or TNF in the literature). In a few other cases, the relative frequency statistic (RF) is reported. This measure attempts to correct for some of the obvious biases of the other statistics (see Hesse and Wapnish 1985 for a discussion), has the advantage of forcing attention onto the way a taxon is represented in a collection, but is not a panacea. Thus the percentage values reported here should be treated cautiously as measures of tendency and little significance assigned to small numerical differences.

Site	Reference	Location	% Pig	Sample
Chalcolithic				
Abundant Pig				
Tel Aviv	Ducos 1968	Cent. Coast	11%	599
Metzger	Ducos 1968	Carmel	44%	394
Wadi Gaza	Ducos 1968	S. Coast	18%	210
Manhatta	Ducos 1968	Jordan V.	26%	358
Gilat	Grigson 1987	Negev	18%	291
Rare/Absent Pig				
Horvat Beter	Angress 1959	Negev	0	
Bir es Safadi	Josien 1955	Negev	0	
Bior abou Matar	Josien 1955	Negev	0	
Early Bronze Age				
Arad	Lernau 1975a	Negev	.3%	1793
Arad	Davis 1976		0	
Aphek/Dalit	Hellwing & Gophna 1984	Coast	1.8%	1488
Ai	Hesse & Wapnish, unpublished	Central Hill	.2%	867
Dan	Wapnish & Hesse, n.d.	Galilee	4%	253
En Shadud	Horwitz 1985	Jezreel	24%	97
Refaim	Horwitz nda	Central	17%	259

Galilee and links the Mediterranean coast and the Jordan Valley. In contrast, from Arad, a large walled town at the arid northern fringe of the Negev, there are two reports (Lernau 1975a, Davis 1976), both indicating litle use of pigs. In environments intermediate between these two extremes intermediate abundances of pig prevail. Evidence comes from two sites at the margin of the coastal plain and the hill country which forms the spine of Palestine—Tel Delit and Tel Aphek. Hellwing and Gophna (1984) report 1.8% pig in a combined sample which merges

the remains from the two tells. Since these two sites occupy somewhat different environmental zones with Tel Aphek located in somewhat better pig country, this average may not accurately reflect either site alone. Simlarly, the Early Bronze Age sample from Ai, located in rough country to the north of Jerusalem overlooking the Jordan Valley from the west, contains only a trace of pig, nine pig bones among 876 identifiable fragments.[3] Evidence of this sort has led Horwitz and Tchernov (1988) to conclude that the frequency of pig declines from north to south in general agreement with the degree of aridity, matching the pattern for cattle and contrasting with that of goats.

There are interesting exceptions to this environmental linkage that point to other pig theories. An important example is discussed by Horwitz and Tchernov (1988). Samples from a site in the Refaim Valley near Jerusalem, in an environment more comparable to Ai than En Shadud yielded 17% pig (Horwitz n.d.a). Further, excavations at Tel Halif, located to the north of Arad (site "L" in Fig. 2) have recently produced evidence of an emphasis on pig exploitation in the Early Bronze Age (Melinda Zeder, personal communication). Zeder suggests that the size and complexity of the site is inversely linked to the use of pig in a manner similar to what was observed in the Middle Bronze Age by Hesse, Metzger and Henson (1986), that is, a pattern in agreement with the political model for pig avoidance—more urbanized towns having less pig use, with rural communities depending on them. This principle could also account for some of the difference in pig abundance between large walled Ai and the tiny Refaim Valley sites.

It is possible to use the Refaim Valley remains to evaluate the pig theory that is based on cultic disdain. In this locale close by Jerusalem, the pigs were recovered only in the domestic debris and never as offerings in the contemporary tombs, although other species were. This example suggests that the pig may have been avoided, rather than sought after, in sacred affairs.

One can add to these unexplained anomalies the relative lack (only about 4%) of pig remains at Tel Dan, a site located in prime pig country. So little is known about the extent of Tel Dan in this period that I cannot speculate whether the political theory may apply there as well.

Middle and Late Bronze Age—ca. 2000-1200 B.C.—Religious theories are useful in interpreting the pig bone sample from the second millenium BC (Table 2, Fig. 2). Most of the evidence from these periods come from complex sites where several periods are represented. One sample—from Sasa in the Upper Galilee (Horwitz 1987)—comes from a tomb dated ca. 2000–1600 BC. Of the 62 bone fragments recovered, 11% were pig. This association of pigs with non-domestic contexts fits nicely with de Vaux's report of pig bones in a subterranean 'cultic' structure at another northern site, Tell Far'ah North (Tirzah) and contrasts with the earlier situation in the Refaim Valley. Thus, though recently doubt has been cast on the ritual significance of the Tirzah building (P. Wapnish, personal communication), these bones provide a thread of support for the theory that the prohibition of pigs originated in disdain for cultic practices—at least someone was using pigs in a ritual setting.[4]

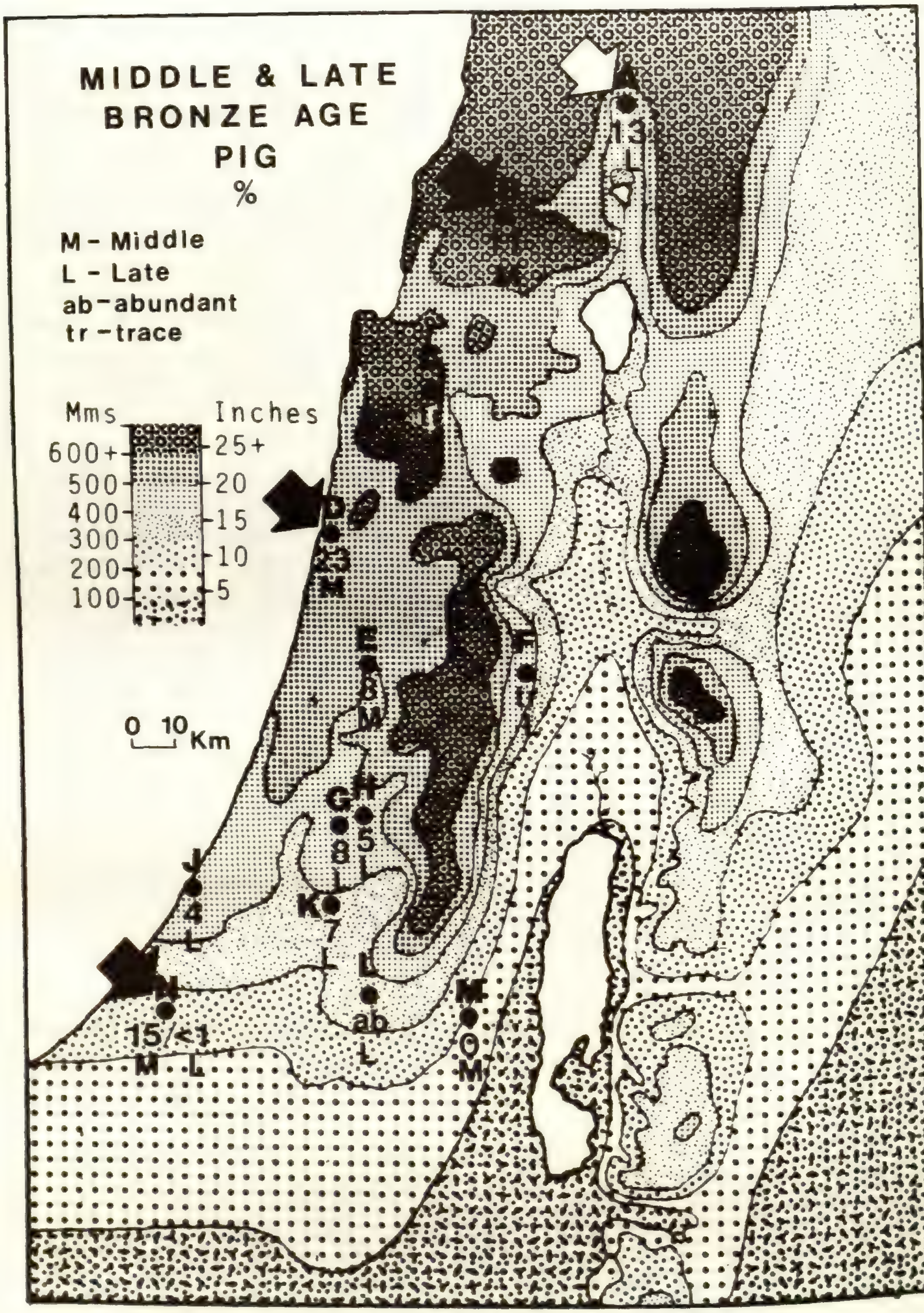

FIG. 2. Middle and Late Bronze Age Pig Abundance. A. Dan, B. Sasa, C. Megiddo, D. Ifshar, E. Aphek, F. Shiloh, G. Miqne, H. Batash, J. Ashkelon, K. Lachish, L. Halif, M. Jebel Qa'aqir, N. Jemmeh.

TABLE 2. *Middle and Late Bronze Age Pig Remains. (2000-1200 BC)*

The ratio between the main exploited species is provided when it could be calculated from the literature. A good deal of the variability in the proportions of the larger cattle to the smaller sheep, goats, and pigs is due to variability in the collection methods used over the last several decades at these sites.

Site	Location	% Pig	Sample	Pig:S/G:Cattle
Middle Bronze Age 2000–1550 BC				
Jemmeh	S. Coast	12% (RF)	2500	1 : 7 : 1
Wapnish & Hesse 1988				
Aphek	C. Coast	8%	1129	1 : 6 : 4
Hellwing & Gophna 1984				
Ifshar	C. Coast	23%	1491	1 : 2 : 1
Henson 1988				
Sasa	Gililee	11%	62	tomb deposit
Horwitz 1987				
Hayyat	Jordan V.	34%	3500	3: 4: 2
Hesse, Metzger & Henson 1986				
Late Bronze Age 1550–1200 BC				
Halif	N. Negev	Common	??	???
Zeder 1983				
Dan	U. Galilee	13%	54	1 : 1 : 3
Wapnish & Hesse nd				
Shiloh	Cent. Hill	trace?	2332	t : 13 : 1
Hellwing & Sadeh 1985				
Lachish	S. Hill	6%	53	1 : 5 : 10
Lernau 1975b				
Lachish	S. Hill	7%	??	1 : 10 : 3
Tchernov & Drori 1983				
Jemmeh	S. Coast	.3%	3950	t : 5 : 1
Wapnish n.d.				

"t" indicates a trace, when this is the estimate of pig in the sample, the ratio between sheep/goat and cattle ignores this small pig sample.

On the other hand, other Middle Bronze Age evidence suggests that some communities practiced ritual avoidance of pigs. Middle Bronze Age I samples from tombs at Jebel Qa'aqir located near Hebron produced no pig bones in association with the burials. Further in the evidence from Tell el-Hayyat in the Jordan Valley (not shown on the map but located across the Jordan River and slightly to the north of site "F"), pig bones are common in the domestic debris from this village, which is roughly contemporary with both tomb sites, while almost none were found in the sequence of temples excavated at the site (Mary Metzger, personal communication). This small scatter of samples is suggestive of a regional pattern.

Hopefully additional excavation will determine whether "cultic" pig use was a "northern" behavior while pigs were disdained in Jordan Valley ritual settings.

Political and social class factors also may contribute to the distribution of pig exploitation in the Middle and Late Bronze Age. The Middle Bronze Age collection from Tell Jemmeh (Wapnish and Hesse 1988:85–86) includes 12% domestic pigs in a sample of domestic debris found in modest dwellings. In the Late Bronze Age, the number of pigs in the sample plunges to less than 1%, though the evidence based on bird remains indicates that relatively wet conditions persisted in the local catchment (Wapnish 1990). The architectural and historical context of these samples suggests an explanation. The Late Bronze Age faunal material comes from a place or public building and is mixed with ceramics the excavator describes as elite (Gus Van Beek, personal communication). Tell Jemmeh is also located on the southern coastal plain of Palestine and was dominated by Egypt during both periods. If Hecker (1984, 1982) is correct about pigs being the food of the working and lower classes in Egypt during the Late Bronze Age, then the patterns at Tell Jemmeh may reflect the establishment of dietary behavior and perhaps food rules based on Egyptian social stratification.

Comparison of the abundances of pigs at several sites in the Middle Bronze Age suggests that the rural–urban dichotomy may also account for some of the variability. To the 12% value for pigs at Tell Jemmeh can be added 8% for Tel Aphek, located on the inner coastal plain (Hellwing and Gophna 1984), and 23% for Tel Ifshar, situated farther to the north and closer to the coast (Henson 1988). Finally the sample from Tell el Hayyat, located near the east bank of the Jordan River, contains in the domestic areas about 34% pig. The contexts from Jemmeh, Ifshar, and Hayyat are all roughly comparable domestic debris. Assuming that the behavioral contexts of the Aphek material are not totally different, we made some comparisons and found two relationships (Hesse, Metzger and Henson 1986). First, the Middle Bronze Age pig proportions are linked to the relative wetness of the environments surrounding each site, a condition also measured by the sheep/goat to cattle ratio—7:1 at Jemmeh, 6:4 at Aphek, 2:1 at Ifshar, and 2:1 at Hayyat. Second, there is a strong inverse correlation with site size—the larger the site, the fewer the pigs. Aphek is about 25 acres while Jemmeh covers 12.5, Ifshar only 5, and Hayyat 1.2. This distribution indicates to us that pig production was a rural subsistance strategy in the Middle Bronze Age.

Further evidence of the rural–urban split comes from the work of Zeder (1983) at Tell Halif, a site located at the southern limit of the central highlands of Canaan. She notes a sharp increase in pig remains in the Late Bronze Age, a trend paralleled by increases in the exploitation of hunted animals. Both trends can be characteristic of a community relying on its own productive systems rather than obtaining food indirectly from market centers (Zeder 1983). Since the site apparently was a special purpose site in that period and was involved with donkey management to a great degree, this seems to support the rural theory for the distribution of pig production. Tel Dan has also produced a Late Bronze Age sample of 54 identifiable bones of which seven were pigs (Wapnish and Hesse n.d.). The proportion of deer in the sample is high (about 25% of the bones found), a pattern also concordant with the Tell Halif record. However, because textual evidence indicates that deer and venison and other hunted foods may be associ-

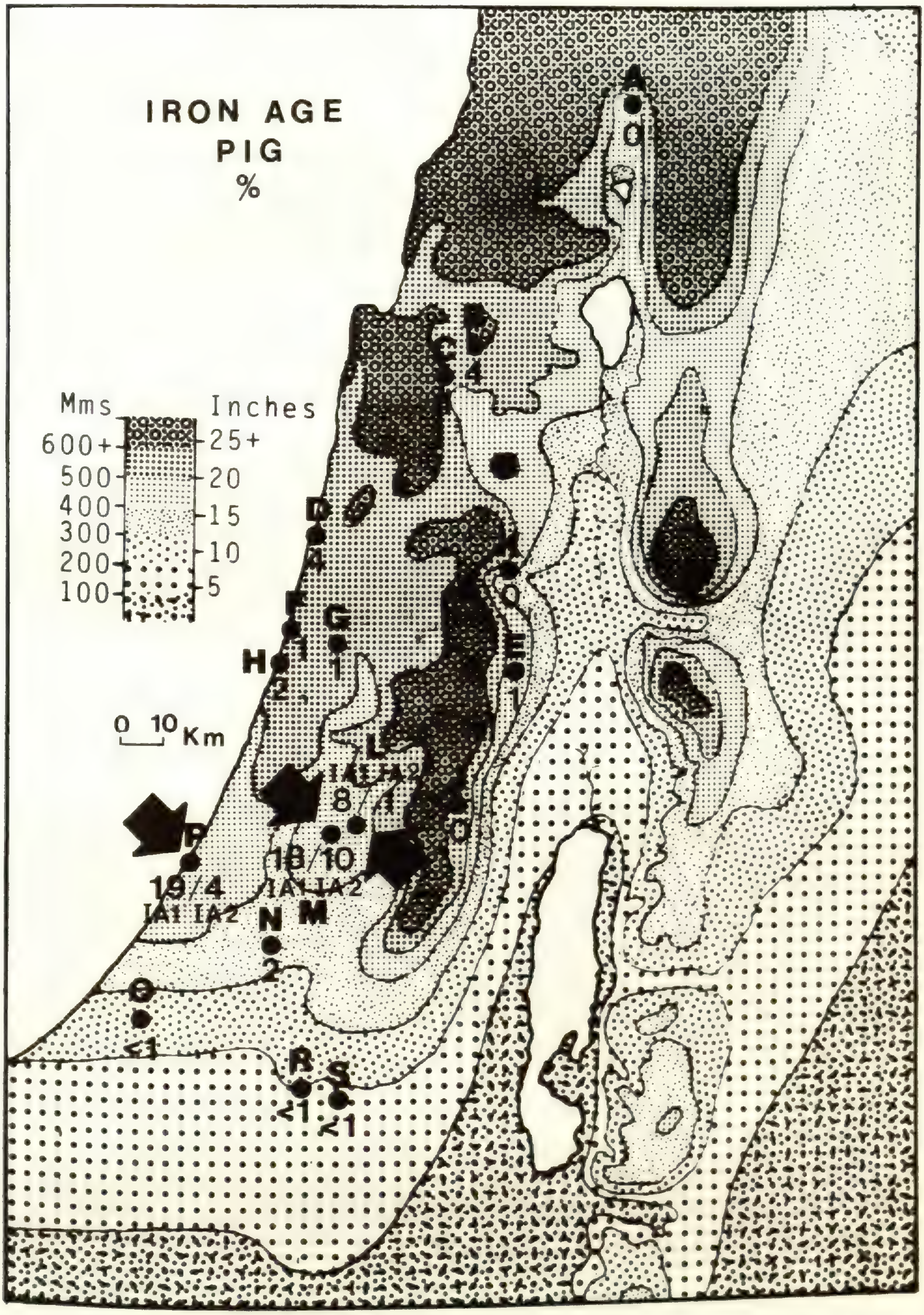

FIG. 3. Iron Age Pig Abundance. A. Dan, B. Wawiyat, C. Qiri, D. Ifshar, E. Shiloh, F. Michal, G. Izbet Sartah, H. Qasile, J. Jerusalem, K. Eyval, L. Batash, M. Miqne, N. Hesi, P. Ashkelon, Q. Jemmeh, R. Beersheba, S. Masos.

ated with elite social classes in Canaan, this statistic may mislead as evidence of economic decentralization. The situation is made more complex by our inability to demonstrate conclusively the domestic or wild status of the Tel Dan pigs. While domestic swine may imply household production, if the pigs were wild, the abundance of pig bones may simply be a byproduct of an increased demand by the elite for wild game for the table and the success of the hunters who supplied them.

Late Bronze Age pig bones from domestic deposits in several other sites have been reported, but are difficult to interpret. The report on the remains from Shiloh mention that pig bones were found but do not specify the period (Hellwing and Sadeh 1985). Given the values in their Table 2, there could not have been many in the Late Bronze Age. From Lachish there are two reports. Lernau (1975b) reports about 6% pig in a sample of 53 bones dominated by cattle. Tchernov and Drori (1983:217, Fig. 28) report about 7% pig in a sample dominated by sheep and goats. Perhaps differences in sample size, sampling methods or within site variability account for these differences.

The Iron Age—ca. 1200–586 BC.—Because the Iron Age is the period of the political and cultural florescence of the Israelites, the examination of the animal bone record for pig related behavior for this period has been most intense. De Vaux's (1972) suggestion that the prohibition of pork was based on an Israelite disdain for neighboring pig lovers was met by considerable enthusiasm in some archaeological circles. In an effort to validate the theory, many scholars focused on a search for the cultic use of pigs, looking for something to which the ancient religious authorities could have reacted.

One often mentioned sample of "pig" bones is the cache of ankle bones, astragali, found in a bowl in Locus 2081 at Megiddo (Loud 1948:44–45), the massive Israelite city in the Jezreel Valley. This collection of bones is part of a group of items of cultic character dated to the end of the 10th century BC (Ottoson 1980: 97–98, Saltz 1978:375, Shiloh 1979:148). It was compared by Lapp (1964:35) to a contemporary cache of 140 bones found at Ta'anach, another important Israelite town and religious center. The Ta'anach collection had been identified as pig bones with the assistance of Crystal Bennett and Lois Glock and this identification was extended to the Megiddo material. Since pig bones are otherwise nearly absent from Ta'anach [also true of Megiddo (Bate 1948), where pigs are represented by only two tooth fragments], Lapp (1967:23) believed that these two extraordinary collections of "pig" astragali must have had a special cultic significance. Perhaps they were examples of apostasy in important Israelite communities—behavior certain to upset the priesthood and perhaps to motivate them to issue ritual legislation. The "cultic pigs" at Ta'anach and Megiddo were used to support the proposition that, "[I]s it not much more likely that the pig's uncleanness is associated with its cultic function rather than the common modernizing interpretation that proscription related to hygienic considerations," a validation of de Vaux's theory.

Unfortunately, as Stager and Wolff (1981:100, note 7) guessed (with the assistance of Patricia Wattenmaker, who examined the published picture of the Megiddo cache), the collection does not contain pigs. Paula Wapnish and the author confirmed this point in an examination of the collection in the Rockefeller Museum of Jerusalem. In fact, of the 684 bones in the collection, 660 are sheep

and goats (7:4), three are from large deer. and 21 are gazelle or roe deer. More generally, no clear evidence of the cultic use of pig in Iron Age Palestine has been found. To the contrary, as will be discussed below, in those Philistine contexts where pigs are common, they are not found in temples or other special contexts.

Iron Age sites in Palestine present a picture of mostly pigless deposits (Table 3, Fig. 3). Considering first the early Iron Age (ca. 1200–1000 BC), the reports from Tel Masos (Tchernov and Drori 1983), Beersheba (Hellwing 1984) and the recent extensive work of Moshe Sadeh (personal communicaton, June 1988) demonstrate that pig remains are very rare in the Negev. Slightly to the north,

TABLE 3. *Iron Age Pig Remains. IA I — Iron Age I, ca. 1200-1000 BC; IA II — Iron Age II, ca. 1000-586 BC.*

Site	Date / Location	% Pig	Sample	Pig:S/G:Cattle
Pig Poor Samples				
Beersheba	IA I / Negev	.3%	1177	t : 6 : 1
Hellwing 1984				
Masos	IA I / Negev	.1%	580	t : 3 : 1
Tchernov and Drori 1983				
Hesi	IA I / Shephelah	0%	96	– : 4 : 1
Hesse and Wapnish unpublished				
Jemmeh	IA I / S. Coast	.2%	1396	t : 4 : 1
Wapnish nd				
Qasile	IA I / Coast	1.5%	251	t : 6 : 1
Davis 1985				
I. Sartah	IA I / Inner Plain	.4%	1041	t : 3 : 2
Hellwing and Adjeman 1986				
Tel Michal	IA I / C. Coast	.7%	???	???
Hellwing 1984				
Shiloh	IA I / C. Hill	.7%	1333	t : 3 : 1
Hellwing 1984				
Dan	IA I / Galilee	0%	77	– : 3 : 1
Wapnish and Hesse nd				
Wawiyat	IA / S. Galilee	4%	604	4 : 13 : 9
Henson 1986				
Qiri	IA / Jezreel	1.4%	949	t : 6 : 1
Davis 1987				
Ifshar	IA II / Coast	4%	47	1 : 4 : 12
Hesse and Wapnish unpublished				
Dan	IA II / Galilee	1% (RF)	286	t : 2 : 3
Wapnish and Hesse n.d.				
Jerusalem	IA II / Ophel	0%	550	– : 5 : 1
Horwitz and Tchernov nd				
Hesi	IA II / Shephelah	1.5%	1383	t : 4 : 1
Hesse and Wapnish unpublished				

TABLE 3 (continued). *Iron Age Pig Remains. IA I — Iron Age I, ca. 1200-1000 BC; IA II — Iron Age II, ca. 1000-586 BC.*

Site	Date / Location	% Pig	Sample	Pig:S/G:Cattle
Pig Rich Samples				
Ashkelon	12/13 / Coast	4% (RF)	101	1 : 15 : 10
Ashkelon	12th / Coast	19% (RF)	109	1 : 2 : 2
Ashkelon	11th / Coast	5% (RF)	179	1 : 2 : 17
Ashkelon	10th / Coast	4% (RF)	216	1: 5 : 19
Hesse 1988				
Miqne	LBIRI / Inner Coast	8% (RF)	1007	1 : 9 : 3
Miqne	IRI / Inner Coast	18% (RF)	502	1 : 2.5 : 2
Miqne	IRII / Inner Coast	10% (RF)	153	1 : 6 : 3
Hesse 1986				
Batash	LB / Shephelah	5%	317	1 : 13 : 5
Batash	IRI / Shephelah	8%	231	1 : 8 : 4
Batash	IRII / Shephelah	.9%	914	1 : 67 : 38
Hesse and Wapnish unpublished				

at Tel Hesi no pigs were found in a small sample of 96 identifiable bone fragments. At Tell Jemmeh near the coast pig bones are also very scarce, only 0.2% in a collection of 1392 fragments (Wapnish n.d.). Further to the north along the coast, from a Philistine sanctuary at Qasile, Davis (1985:148) reports 1.5% pig. Hellwing (1984) reports that comparable materials from both Shiloh in the central hill country and Tel Michal along the coast contained 0.7% pig. The small site of Izbet Sartah produced five pig bones from mixed loci (Hellwing and Adjeman 1986:Table 8.2, p. 142). The village is located at the margin of the central hill country and the coastal plain and has been identified as an extremely early Israelite settlement by the excavators. The excavators believe the five bones, which are 0.4% of the 1041 remains in the collection, to be intrusive from Byzantine levels. I was able to find only one pig bone in the collections from the early Iron Age settlements of Ai and Raddana (H on Figure 1) in the spine of the central hill country. The presence of Byzantine material in nearby deposits may also explain this find.[5] The materials from the controversial site (ritual center or fort?) of Eyval in the northern reaches of the central hill country also contain no pig remains (Horwitz, n.d.b.). At Tel Dan in the Galilee, no pig remains were found in either of the two early Iron age samples from different sectors of the site (Wapnish and Hesse n.d.). Finally, at Wawiyat, a small settlement with substantial architecture located in the southern Galilee, Henson (1986) has found a few pig bones, about 4% of a sample of mostly early Iron Age date.

Expanding the search for pig remains to later phases of the Iron Age as well as to samples not well defined chronologically within the Iron Age just produces more negative results. A confused picture emerges from the excavations at Lachish, at the southern margin of the central hill country. Lernau's (1975b) report mentions no pig bones in the Iron Age or succeeding Hellenistic strata. However,

Bate (1953) described a series of pig skulls coming from a deposit of animal remains that had accumulated on top of human ossuaries. In her report Bate (1953:410) warns that the collections "may be the result of selective collection" since most of the bones sent to her for identification were skulls. Moreover, the presence of a camel in the deposit suggests that the deposit postdates the Iron Age.[6] Lastly, the most common domestic stock from all periods in Palestine, i.e., sheep and goats, are not recorded at all. Nevertheless, these have been cited as evidence for Iron Age pig use at a Judaean city (Wright 1964:305). I would suggest this to be another example of the enthusiastic search for the "cultic pig." The characteristics of the collection and its uncertain stratigraphic disposition make it unlikely to reflect Iron Age behavior.

Several locales within Palestine that in earlier periods had extensive pig use show almost none in the Iron Age. Davis (1987) finds 1.4% pig at Tel Qiri, a site in the Jezreel located in an area which in the Early Bronze Age found pig fairly abundant. The same can be said for the site of Ifshar, notable for Middle Bronze Age pig exploitation, where 47 Iron II (1000–586 BC) dated fragments included only two pig bones, both of which seem large for domestic swine. In Iron Age II Tel Dan, four pig bones, all of seemingly wild morphology, were found in 9th–8th century BC deposits (Wapnish and Hesse n.d.). As far as Jerusalem is concerned, a sample of remains from the Ophel produced no pig bones (Horwitz and Tchernov n.d.) but some are present in the City of David excavation materials (Liora Horwitz, personal communication). Finally, a sample of Iron II material from Tel Hesi produced 1.5% (TNF) for 1383 bone fragments.

The question remains, where were the pigs during the Iron Age? So far, three sites (Tel Miqne, Tel Batash, and Ashkelon) located on the coastal plain and the edge of the rolling hill country known as the Shephelah have produced parallel patterns of significant pig use (bottom, Table 3). All were important Philistine communities. The initial report on the fauna of Miqne, based on the collections from the first two seasons, indicated a sharp rise in the pig remains at the onset of the Iron Age (Hesse 1986). Examination of the material from Batash and subsequent analysis of the 1984 and 1985 collections from Miqne confirmed this pattern (Hesse and Wapnish 1987). These results were duplicated in the analysis of the 1985 collection of Iron Age remains from Ashkelon (Hesse 1988). Several comments must be made about the data from Miqne and Batash. In the case of the first site, much of the material comes from loci which are well defined stratigraphically but contain ceramics of different periods. A measure of the degree of ceramic mixture was developed for each locus and the locus classified into 12 types based on the relative contribution of pottery of different date. By arranging these types in chronological order and calculating the pig bone content, we could show that there was a distinct peak in the most pure Iron I ceramic materials. Thus the three period breakdown shown in Table 3 blurs and diminishes the actual sharpness of the increase in pig at the onset of Iron I. The same bias reduces the degree of decline in the Iron II materials. In the case of Batash, the size of the increase as reported in Table 3 also blurs and diminishes the increase in pig. A second bias also affects our understanding of the pig use at these two sites. At both tell sites pigs are more common in some architectural contexts than

others. At Miqne pigs are absent from the elite building, perhaps a ritual center (Trude Dothan, personal communication), at the center of the site. I also note in this connection that the sanctuary sample from Philistine Qasile mentioned above also contained few pig bones. At Batash some room complexes are pig rich, other contemporary structures are pig poor (Hesse and Wapnish 1987). Looking at pig rich parts of the site in Iron I yields values of about 14% pig. Pig exploitation was clearly more important for some sectors of these Philistine communities than the simple period percentages would indicate.

The suddeness of the appearance of pig use at the three sites and its correlation with the settlement of the Philistines supports the ethnic theory of pig use. If the Philistines migrated from lands surrounding the Aegean as many theorize, then their pig husbandry may have roots in what had been successful adaptations to their old homeland. Philistine pig use also may have been related to the process of settlement following the pastoral development theory. Since there are no samples from small Philistine sites, the possibility that rural–urban factors were involved cannot be assessed. However, there is evidence that the pig use was structured by social class and none that the animal was manipulated ritually.

The decline of the pig at Miqne and Batash is not well dated. The samples thus far available from both sites fit either rather early in Iron I or late in Iron II. Only at Ashkelon is there a hint that the reduction in the exploitation of pig occurred early in the Iron Age. As a result, I am not able to specify whether the regional decline began as a process associated with the growth and consolidation of the Philistines, the major political changes associated with early Iron II, or the expansion of the olive oil industry in later Iron II, particularly at Miqne. The important point to note is that the use of pig in the Iron Age appears to have been a very restricted event, both temporally and spatially. Nowhere do we see the kind of intense exploitation of the animal found in the Middle Bronze Age.

Post Iron Age Pigs.—The zooarchaeological record for the periods following the Iron Age in Cisjordan is scanty at best. In the late Iron II, Persian, and Hellenistic sample from Tell Jemmeh, pig never accounts for more than 1% of the sample (Wapish n.d.). At Ashkelon, a small Persian period sample has been studied by Grantham (1988). Of the 118 identifiable bones only three were from pigs. Field readings from a much larger sample confirm this impression. Apparently that was soon to change. Though they have not yet been studied in detail, the samples from the Classical, Byantine, and Islamic periods at Ashkelon indicate that pork was a mainstay of the diet. This is also reflected in the material reported by Roll and Ayalon (1987:73) from the market place at Apollonia—Arsuf. In Room 557, dated to the 9th c. A.D., the large accumulation of finds included numbers of pig bones. Typically the later periods are marked by abundances of chicken, as well. Textual materials (Urban 1985:149) suggest that the Golan should have been utilized for pig production. However, the only two samples of material (which come from periods later than that speciically referred to by Urman) described, those from Kanaf and Qazrin, include few pigs though substantial amounts of chicken. Qazrin: 0.4% pig in 1684 specimens; Kanaf: 1.8% in 983 specimens (Hesse and Wapnish, unpublished data).

CONCLUSIONS

This paper set out to review the patterns of pig use reported in the zooarchaeological literature to provide a body of descriptive evidence to apply to the theoretical problem of pig avoidance in Palestine. Several patterns of pig use and avoidance emerged. In several periods a link between rainfall and pig use was discovered. This was most clear in the Chalcolithic and Early Bronze Age distributions. In the Middle Bronze Age two possible superimposed processes could be seen. There was some contradictory evidence that pig had some kind of ritual signficance—positive based on samples from the Galilee, negative in the Jordan Valley. In addition, there was an inverse correlation between site size and the exploitation of pigs. This agrees with the political model of taxation and anti-pig legislation. This result was repeated in the scanty evidence of the Late Bronze Age. The Iron Age produced a strikingly different pattern. Pigs are only common in the southern coastal plain, the homeland of the Philistines. There they appear almost suddenly and are associated with non-ceremonial architecture and deposits. Later in the Iron Age the use of pigs declines. One datum suggests that this is early in the period. Since the increase in pig coincides with the appearance of the distinctive ceramics of the Sea Peoples/Philistines and because the use of pork may be a major foodway of only some sectors of the communities, it is tempting to link the two causally. Alternatively however, the impact of the Philistines may have disrupted the regular pastoral systems of the south central coastal plain, restricting access to the flocks of the highlands and forcing the inhabitants to fall back on the species best adapted to their environment in the plains, cattle and pigs. Initially, at least, central marketing and administration of the agro-pastoral sector in the region would have been weak, further encouraging independent production. Thus the early Iron Age materials can be used to argue positively for a number of the pig use theories. Finally pigs are little utilized in the later phases of the Iron Age and Persian period. It is only beginning in the classical periods that they are again a mainstay of the urban diet, but only on the coast. No evidence of their use at inland sites has been reported.

To turn this body of data to a consideration of the food proscriptions in the Bible is a thorny problem. The texts, Deuteronomy and Leviticus, which contain the critical laws, are the result of an extremely complex history of editing. Most scholars agree that the form in which we now see these Biblical books was established in the final centuries of the Iron Age or the Persian period. However, there is vast disagreement over what elements of these texts are the result of the final editing process and which reflect cultural traditions of great antiquity. Thus the appropriate historical setting for the first legislation of the pig prohibition is simply not known with any accuracy. From the perspective of the physical evidence of pig use, it is clear that the final editing was done in a period when pork consumption was an almost invisible subsistence alternative. If, on the assumption that rules are not made to prohibit things that no one is doing, that can be taken as 'proof' that the laws are of greater antiquity than the late Iron Age, then two behavioral settings for pig prohibition can be suggested. The Bronze Age data suggests that political centralization may have encouraged the restric-

tion or pig husbandry, a principle that could have been reused as the Israelite polity began to form in the central highlights early in the Iron Age. Alternatively, pig hate can be linked to an important food of the traditional enemy, the Philistines, though this argument is weakened by the lack of evidence that the Philistines were symbolically tied to the animal.

Despite the many reports of bone remains from Palestine, we still have only an outline of the changes which occurred in the pastoral systems which supported the region's successive occupants. In the case of pork production, in particular, because of the relative rarity of pig bones in most samples, much more excavation and description will be necessary to fill in the holes.

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NOTES

[1]The transition between the Late Bronze Age and the Early Iron Age in the eastern Mediterranean is usually dated to approximately 1200 BC. It was a time of considerable turbulence. Egyptian control of the Canaanite coast was receding and significant new actors began to appear on the political stage. Among the new arrivals, a number of invaders usually lumped under the term "seapeoples," were the Philistines. The Philistines' great rival, the Israelites, also seem to have emerged from Canaanite society and achieved a political identity in the minds of the surrounding nations by this time as well, as an important new interpretation of extra-Biblical evidence suggests (Yurco 1990).

[2]The Iron Age of Canaan is divided into several historical phases. Iron I is the period of Israelite settlement and coalescence into the United Monarchy under David and Solomon. In approximately 925 BC the united kingdom of Judah and Israel divided, an event which marks the beginning of Iron II. Iron II is marked by the steady increase in the power of the Mesopotamians in the region—the capital of Israel, Samaria, fell in 722 BC to the Assyrians, and, finally, the capital of Judah, Jerusalem, was destroyed by the Babylonians in 586 BC (see Miller and Hayes 1986).

[3]This unpublished sample has been studied by Paula Wapnish and the author.

[4]Work at the Jordan Valley site of Beth Shean in the spring and summer of 1990 have produced another possible example of "ritual pig." The excavations concentrated on a stratified sequence of temples and in a Late Bronze Age I (ca. 1550 BC) stratum, the remains of what the excavator describes as a "pig barbecue" were found (Amihai Mazar, personal communication). Since I have not seen these remains and they have not yet been published, I am reticent to cite them as conclusive evidence of ritual pig sacrifice. Nevertheless they are potentially extraordinary finds.

[5]Because of the untimely death of Joseph Callaway, Zvi Lederman has recently been assigned the task of publishing the Iron Age materials from Ai and Raddana. His preliminary study of the excavation records suggests that the pig bone may be intrusive.

[6]In a recent paper Arensburg (1990) has illustrated the non-Iron age, non-Judean character of the human remains in this ossuary.

BOOK REVIEW

A Textbook of Economic Botany. A.V.S.S. Samba Murty and N.S. Subrahmanyam. New Delhi, India: Wiley Eastern Limited. 1989. 875 pp. illus. Rs 90.00 (U.S. $5.50). ISBN 0–85226–880–7.

This is more than a textbook but just short of an encyclopedic reference to the major economic plants of the world. Emphasis is understandably directed toward the needs of the Indian student at both the undergraduate and graduate levels, but the important species and varieties grown elsewhere are not neglected.

Twenty–five chapters cover the usual gamut of economic crops: cereals, millets, legumes, oil seeds, fibers, lumber, tuber crops, condiments, drug plants and so on; antibiotics and useful microorganisms are also included. Of interest to plant scientists well beyond the University student level are data supplied for each species considered: botanical names, English and local Indian names, origin and distribution (according to Vavilov), ecology, cultivation, soil requirements, processing of the raw material where appropriate, yields/hectare, chromosome numbers, chemical structures when relevant, insect pests, diseases and their management, as well as tables giving Indian and world production.

The book is illustrated with black–and–white photographs, line drawings and maps to add to an understanding of the text. Seven appendices list biochemical tests for major nutritional constituents, Indian research institutes involved in Economic Botany, a table of units used in the text, a list of ornamental plants, Vavilov's grouping of plants according to center of origin and distribution, chromosome numbers, a glossary of terms, and, finally, a comprehensive bibliography and index.

All of this comes at some expense to the reader: misspellings and typographical errors are common; many of the chemical structures are incorrectly rendered; punctuation and syntax leave much to be desired. But the reader interested in one or another of the many aspects of Economic Botany may wish to overlook these deficiences in return for a wealth of information at an unbelievably modest price.

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J. Ethnobiol. 10(2):227–235 Winter 1990

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS: FALL 1989—FALL 1990

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This is the eighth in an annual series of bibliographies listing selected dissertations drawn from the pages of Dissertation Abstracts (D.A.). All listings were made by scanning the titles and abstracts published in D.A. and making subjective decisions as to which ones might be relevant to work in ethnobiology or related disciplines such as ecological anthropology and economic botany.

Dissertations categorized in D.A. under Agricultural Economics, American Studies, Anthropology, Biology, Botany, Chemistry, Ecology, Folklore, Geography, Health Science, Language, Linguistics, Paleoecology, Sociology, and Zoology were considered for inclusion in the list. An attempt was made to be as inclusive as possible, but some dissertations may have been overlooked. Comments and suggestions would be welcome for items to include in next year's edition. Dates covered by the present listing include: Volume A (Humanities and Social Sciences): September 1989–August 1990; Volume B (Sciences and Engineering): September 1989–August 1990; Volume C (Worldwide): Fall 1989–Winter 1989. Note that these are the dates for the issues of D.A. in which the abstracts appear, rather than the dates of acceptance of the dissertations themselves.

The dissertations are listed alphabetically, along with the year of acceptance, title, institution, length, advisor or major professor, number(s) of the page(s) in D.A. in which the abstract may be found, and University Microfilm order number, within the limits of the information given.

Most of the dissertations accepted at institutions in the United States and some of those from Australia, Canada, South Africa, and the United Kingdom may be obtained from University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106, either on microfilm or published by microfilm xerography. Quality of printed matter is generally excellent, but that of figures and photographs varies with the quality of the original. Current prices may be obtained by calling 800-521-3042; 313-761-4700 from Alaska, Hawaii, or Michigan; or 800-268-6090 from Canada. Further information and current prices may also be obtained from UMI Dissertations Information Service, 300 North Zeeb Road, Ann Arbor, MI 48106.

RESUMEN.—En este bibliografía se incluyen disertaciones recientes de interés a los etnobiologos. Por cada uno se da el número de la página donde se halla el resumen en Dissertation Abstracts (D.A.), y el numero de encargar un ejamplar de la disertación de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106 USA (teléphono: 313-761-4700 o 800-521-3042; desde Canada 800-268-6090).

RESUME.—Cette bibliographie comprend quelques dissertationes recentes d'interet aux ethnobiologistes. Chez chaqu-une on donne le numéro de la page où se trouve le résumé dans Dissertation Abstracts (D.A.), et le numéro de commander un exemplaire de la dissertations de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106 USA (telephone: 313-761-4700 ou 800-521-3042; de Canada 800-268-6090).

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ABSTRACTS

of presentations (contributed papers, poster and film sessions) at the Thirteenth Annual Conference of the Society of Ethnobiology Arizona State University, Tempe, Arizona 21-24 March 1990

Karen R. ADAMS, Crow Canyon Archaeological Center, Cortez, Colorado

A REVIEW OF ANCIENT TOBACCO *(NICOTIANA)* USE IN THE PREHISTORIC SOUTHWESTERN UNITED STATES

Recent large scale archaeological projects that utilize flotation techniques to recover plant parts have broadened our understanding of ancient tobacco distribution among Anasazi, Mogollon and Hohokam cultures. Species identified include *Nicotiana attenuata, N. trigonophylla* and the domesticates *N. rustica* and *N. tabacum*. Both charred and uncharred parts, especially the seeds and stems, are reported. Contexts of recovery include floors, various pits, hearths and other thermal features, and inside ceramic vessels and "reedgrass cigarettes." The tobacco parts occur in Anasazi and Mogollon sites dating as early as the period A.D. 500–700, and in Hohokam sites dating to the A.D. 900's. Attempts to identify seeds on the basis of size, shape and surface reticulation patterns may be hampered by our incomplete knowledge of possible overlap of the characteristics between species. To provide secure species identifications we must provide detailed descriptions of all tobacco parts recovered from ancient sites, as well as study normal and charred modern populations to perceive both the average and the range of characteristics expressed.

Janis ALCORN, AAAS Fellow, Agency for International Development, Washington, D.C.

THE RELATIONSHIP BETWEEN BIODIVERSITY CONSERVATION, ECONOMIC DEVELOPMENT, AND GROSS NATURE PRODUCT

The challenge of making ethnobiological information relevant to policy makers and planners is formidable. The need for biodiversity conservation on two fronts (natural ecosystems and human-dominated ecosystems) is not appreciated by most planners. Interest in the economics of sustainable development is currently high, but the relationship between 1) contributions of biota to local economies and 2) national economic stability and growth is not widely appreciated. The concept of "Gross Nature Product" was coined by Anil Agarwal. I will explore the Gross Nature Product concept using examples from Mexico and India. It is a potentially powerful vehicle to inform development planners about the economic importance of biodiversity management in rural, human-dominated landscapes.

Rosalia ALVAREZ, Carlos ALVARES and Julio RUIZ
Escuela Nacional de Antropologia e Historia, INAH, Mexico City, Mexico
AN OBSIDIAN WORKSHOP WITH BOTANICAL REMAINS: THE CENTRAL PLAZA OF MEXICO CITY

The Archaeological Recovery Department of INAH initiated studies of the Plaza of the Nationalized Bank in 1986. It discovered an interesting obsidian workshop of the Aztecs below this central plaza. The plaza had been built over an ancient agricultural ''chinampa'' raised field. The obsidian matrix holds within it many different elements: Aztec pottery fragments; charcoal; bone; insects; shells of aquatic invertebrates; and botanical remains. The botanical remains include seeds of wild, weedy and cultivated plants that enable the reconstruction of culture/environment interrelations, diets and microenvironments. The lacustrine habitat included *Scirpus, Cyperus, Polygonum, Hydrocotyle, Nymphaea* and *Ruppia,* the latter a halophyte. The terrestrial (raised field) habitat included *Zea, Cucurbita, Chenopodium, Physalis, Solanum, Amaranthus* and *Oxalis.* Gradual salinization is indicated by the take-over of basin habitats by *Suaeda, Sesuvium* and *Portulaca.*

E.N. ANDERSON, University of California, Riverside, CA
NOTES ON DOORYARD GARDENS

Comparative research (funded by University of California) on southeast Asian and southeast Mexican dooryard gardens is now under way. Preliminary results show considerable similarity in dooryard garden structure and function in these two areas. Species have been exchanged in both directions, leading to great similarity of the gardens. These gardens offer great potential for improving the life of poorer rural families.

M. Kat ANDERSON, Department of Forestry and Resource Management, University of California at Berkeley, Berkeley, CA
CALIFORNIA INDIAN HORTICULTURE: REDBUD MANAGEMENT AND USE BY THE SOUTHERN SIERRA MIWOK

A survey of California ethnohistoric literature and ethnographic interviews reveal that historically California Indians had an active role in manipulating the plant architecture of redbud *Cercis occidentalis* Torr. ex Gray with coppice and fire management to make the branches suitable for basketry material. This offers evidence that hunter-gatherers practiced horticulture in California plant communities. Results from a study conducted in Sierra National Forest which quantifies the regeneration of redbud in response to ''mimicked'' management practices of the Southern Sierra Miwok are reported. Personal observations regarding the generous presence of redbuds in proximity to major Southern Sierra Miwok archaeological sites suggest that some element of human activity was responsible for the successful regeneration of redbud at these sites. It is proposed that the introduction of anthropogenic fire, pruning, and weeding historically maintained and enhanced populations of redbud, extending its range and distribution.

Aleandro DE AVILA, Instituto Tecnologico de Oaxaca, Oaxaca, Mexico
CORN AND OPIUM IN A CLOUD FOREST OF SOUTHERN MEXICO

Indigenous communities of the Sierra Madre del Sur in the state of Oaxaca and Guerrero, Mexico, live in an extremely diverse environment ranging from 500 to 3000m above sea level. Various subsistence crops are planted at different altitudes, mostly in slash and burn plots. The majority of families are unable to grow enough to feed themselves, and rely on goat herding, migrant labor, and increasingly drug cultivation to obtain cash to buy corn. I describe in this paper corn and opium agriculture in the area of Coycoyan, Oaxaca, and discuss some apparent effects of the opium trade on Mixtec culture. I denounce indiscriminate violence and other abuses committed against the Mixtec communities in the name of drug enforcement.

Frank E. BAYHAM, California State University, Chico, CA
AN EXPERIMENT IN INTERDISCIPLINARY INSTRUCTION: A ZOOARCHAEOLOGY FIELD COURSE

Adequate training and instruction in zooarchaeology has long been confounded by the interdisciplinary nature of the field. Knowledge of vertebrate osteology and life history strategies, while essential, is not sufficient to meet the theoretical and methodological challenges of modern archeaological background focusing on the inherent complexity of cultural systems and human behavior is generally neglectful of complex ecological relationships which may influence variability in the archaeological record. In an effort to help rectify this situation, a field course in zooarchaeology has been developed to break down the disciplinary automony which constrains student development. The goals and format of this course which integrates zooarchaeological identification techniques and field ecology at the Eagle Lake Biological Field Station are discussed.

Vorsila L. BOHRER, Southwest Ethnobotanical Enterprises, Portales, NM
THE PATH OF THE SUN IN RELATION TO MAIZE PLANTING RITUAL

Planting dates and planting prayers to the "four corners" among the Pueblo Indians and in diffuse locations in Mesoamerica derive from perceptions of the yearly paths of the sun. The impression of the daily path of the sun is expressed in spiral counter-clockwise planting. Archaeological evidence suggests the organizing conceptions from which such customs originate predate A.D. 300 (the Classic) in Mesoamerica.

Jannette BRAND, B. Janelle SNOW, A. Stewart TRUSWELL,
University of Sydney, Sydney, Australia, and
Gary P. NABHAN, Desert Botanical Garden, Phoenix, AZ
HYPOGLYCEMIC EFFECTS OF NATIVE DESERT FOODS OF THE RIVER PIMA: PROTECTION FOR A DIABETES-SUSCEPTIBLE POPULATION?

The River Pima (Akimel O'Odham) tribe of arid, central Arizona has the highest documented prevalence of adult-onset diabetes (NIDDM) of any ethnic

group in the world. Up to 35% of their adult population develop this nutrition-related disease, but this high prevalence has developed since the 1940s as a result of dietary acculturation. In this study, six staple foods traditionally consumed by the Pima were analyzed for their invitro glycemic, insulin reponses, and invitro starch digestibility: 60 day flour corn, lima beans, white and yellow tepary beans, mesquite and Emory oak acorns. The calculated glycemic indices were all low, ranging from 16±2 for acorns to 40±5 for corn. Other traditional Pima foods, including chia, prickly pear pads and fruit, and plantago contain hygroscopic mucilages which also appear to have hypoglycemic effects. We hypothesize that desert floras may be relatively rich in plant foods which contain such hypoglycemia mucilages which slow sugar absorption and digestion, because these same mucilages retard water loss in seedlings or established plants. We also hypothesize that the slow digestibility of native foods protected the Pima and other desert Indians from developing diabetes.

Carol B. BRANDT and Patricia A. RUPPE',
Zuni Archaeology Program, Zuni, NM
WOOD USE IN THE ZUNI RIVER VALLEY: THE ARCHAEOBOTANICAL DATA

A model for local deforestation proposed by Kohler and Matthews (1988) is applied to the charred wood data from 16 archaeological sites in the Zuni River Valley. These data provide insight into local patterns for selection for firewood and construction timbers from Basketmaker III through Late Historic periods (AD 400–1900). Overall, the charred wood data reflect current environmental conditions where conifers dominate the vegetation of Zuni River Valley. Post-AD 1000, however, the frequency of shrubby wood used for fuel increases in the archaeobotanical assemblage. This change in wood use is compared to tree-ring data, plant use, and palynological studies in the Zuni River Valley.

Barrett P. BRENTON, University of Massachusetts, Amherst, MA
USE OF FERMENTED FOODS AMONG NATIVE NORTH AMERICANS: ETHNOHISTORIC AND ETHNOGRAPHIC PERSPECTIVES

The use of fermented foods among Native North Americans can be viewed as one in a series of technological innovations responding to or creating a change in subsistence activities. In turn, an understanding of human-plant interactions and horticultural activities cannot be complete without incorporating the role of microorganisms. The fermentation of a foodstuff can alter the storability, nutritional quality, organoleptic properties (smell, taste, texture, appearance), and the medicinal potential of foods. This paper reviews the use of fermented foods from ethnohistoric and ethnographic perspectives. This information is then used to infer the importance of food fermentations to the health and nutrition of Native North American Populations, which to date has been given little or no attention. In addition, further avenues for investigating the nature of prehistoric and indigenous/traditional fermentations are discussed.

Carmen BURCH, Connecticut College, New London, CT
SEEDS AND DEEDS IN THE ASIAN TROPICAL FOREST: TO MAKI CULTIVATION PRACTICES AND CROP DIVERSITY

Polycultural systems of traditional farmers living in Asian tropical forests are considered to be valuable reservoirs of cultivar diversity, but there is a limited understanding of the ongoing process by which the store of plant varieties is selected, maintained or expanded. This paper, based on field research with upland forest cultivators on the island of Sulawesi (Indonesia), reports on the To Maki's knowledge and practices related to the management of plant resources, including attention to To Maki experimentation with unfamiliar varieties and the incorporation of new cultivars into cropping regimens. The To Maki handling of plant resources comments on the flexibility of traditional farmers in responding to short and long term changes and suggests a role for diversified cultivation systems in accommodating both conservation and development in tropical forest environments.

Martha Ames BURGESS and Kevin A. DAHL, Native Seeds/SEARCH, Tucson, AZ
YES, YOU CAN EAT THAT (AND YOU SHOULD!): NATIVE SEEDS/SEARCH'S EDUCATIONAL ACTIVITIES

Native Seeds/SEARCH is a non-profit conservation organization whose mission is to preserve the crops grown by Native Americans in the Greater Southwest. In large measure, its activities involve educating the public about the wonderful diversity of food plants grown in this region, including corn, squash, beans and others. Tools used to reach new audiences with this message include a slide-tape presentation, setting up booths at selected special events, a hands-on mini-museum, quarterly newsletter, an informative annual seed catalog, and workshops. Celebrations to mark the beginning and ending of the growing cycle have become educational events in themselves: our San Juan's Day Feast heralds the traditional summer planting season and La Fiesta de los Chiles observes the harvest. The success of this multi-level educational approach can be measured by the healthy growth of the organization in recent years.

Robert BYE and Edelmira LINARES, Jardín Botánico, Universidad Naçional Autonoma de México, México, DF
ETHNOBOTANY OF MARKETS IN EL BAJIO, GUANAJUATO, MEXICO

El Bajio has been the most fertile agricultural region in Mexico since Spanish colonization in 1540 A.D. The intense agro-industrial development and the migration of laborers to and from the USA have changed traditional plant-human interactions. A study of local markets with emphasis on medicinal and edible plants documents 141 useful species with reports of 95 being medicinal, 103 edible, 11 beverages and 10 condiments. Plant management systems include "huamiles" (dry, rock agricultural technique) and associated "monte," houseyard gardens

and irrigated specialty gardens. Cultivated plants transplanted from wild populations include *Achillea, Heterotheca & Jatropha.* Local domestication of various cacti *(Opuntia & Stenocereus)* have generated a wide variety of edible fruits. Typical Mexican medicinal plant complexes (e.g., toronjil, árnica, cola de caballo) are encountered. Although 15 bean varieties are cultivated locally, only 5 types imported from adjacent geoeconomic regions are sold in the market. Despite the drastic alterations of the socioeconomic structure of El Bajio, traditional ethnobotanical processes still function, usually in marginal areas.

Luis CERVANTES SERVIN and Robert BYE, Jardín Botánico
Universidad Nacional Autónoma de México, México, DF

USEFUL PLANTS OF THE CENTRAL AND SOUTHERN COAST OF JALISCO, MEXICO

The exploitation of deciduous tropical forests along the Pacific coast after the Spanish Conquest was limited due to annihilation of Nahuatl inhabitants and to the rugged terrain. After the Mexican Revolution of 1910, the areas was resettled by immigrants from Jalisco and adjacent states. Dramatic changes have occurred on both private and communal lands after the construction of the federal coastal highway in 1970. Open interviews and questionnnaires were conducted with the assistance of 266 individuals (56 adults and 210 children between the ages of 14 and 56) of different socioeconomic levels. The distribution of the 153 useful species in 64 families according to the most common use categories are: medicinal (41.9%), edible (19.2%), construction (14.15%) and fuelwood (4%). Since most of the inhabitants families have occupied the area for two or less generations, it is not surprising that most of the cultivated plants are exotic. Nonetheless, manipulation of contrasting forms with native species (e.g. *Dioscorea nelsonii* Uline ex Kunth) does occur. The proportion of utilized wild species by plant families corresponds to the dominant taxa of the local flora.

David A. CLEVELAND and Daniela SOLERI, Center for People, Food and Environment, Tucson, AZ

FOOD FROM DRYLAND GARDENS

This poster displays excerpts from research on small scale household food production in the world's drylands. The focus has been the complementarity of local or indigenous knowledge and basic ''scientific'' principles for supporting food gardens in those areas. Both approaches are based on experimentation and observation, but reflect different attitudes and resources. Indigenous techniques from diverse drylands illustrate plant, soil, and water management which is uniquely suited to the needs of the gardeners and their environment. Excerpts and line drawings from a newly published book of the same name are used along with some additional photographs of indigenous household gardens.

David A. CLEVELAND and Daniela SOLERI, Center for People, Food and Environment, Tucson, AZ

CULTURAL AND BIOLOGICAL DIVERSITY IN AGRICULTURE: WHO NEEDS IT?

The debate over the function of human cultural diversity and crop genetic diversity in agricultural systems often produces more heat than light. This is because of the failure to distinguish between issues of fact and issues of value. The former are subject to evaluation through traditional positivist scientific procedures. While values are affected by the objective environment, they are embedded within cultural systems and can only be understood as components of those systems. Data show that biological diversity enhances yield stability at the cost of relatively low production. Increasing production with the use of modern crop varieties reduces crop genetic diversity and increases variance and covariance in annual yields. Data on the relationship between cultural and crop genetic diversity and stability suggests a positive correlation. Choices between diversity and stability are not based on data alone, but also on values which are not articulated or even appreciated by decision makers. Understanding the cultural and historical context of these values and their social and ecological implications for the future can shed more light on the choices.

Kevin A. DAHL, Native Seeds/SEARCH, Tucson, AZ

CORN SOOT WOMAN'S TIMELESS LESSON: EAT YOUR SMUT

A Cochiti Pueblo (New Mexico) folktale that encourages women not to discard maize afflicted with corn smut (*Ustilago maydis* D.C.) might be puzzling to most non-native farmers and gardeners in the U.S. who treat this fungus as a repugnant pest. A survey of studies of southwestern Native American food sources shows that corn smut was enjoyed as food and used for medicine and other purposes. In southern Mexico, *cuitlacoche* (corn smut) is both a traditional food and a highly praised gourmet item, available fresh in season as a market vegetable and year-round as a canned food. The author proposes that the U.S. has rejected corn smut as food because it simply rejects most fungal foods, and that there were unfounded concerns about its toxicity. Based on *cuitlacoche's* success in Mexico City's *nueva cocina Mexicana,* corn smut may find acceptance as a new ingredient for southwestern *nouvelle cuisine.*

Frank DIRRIGL, Jr., University of Connecticut, Storrs, CT

ETHNOZOOLOGY AS AN AID TO BAT CONSERVATION

The conservation of bats has received increased attention because of the important ecological role of bats in the environment. Through open-ended interviewing, students at the University of Connecticut were sampled for their "bat knowledge" and "bat attitude." Content analysis of informant interviews was performed to determine what knowledge was shared. Subjects were ranked according to their ethnographic descriptions and attitudes regarding bats to deter-

mine why a person may like or dislike bats. This study emphasizes the utility of and need for ethnozoological studies in designing public information pamphlets to promote the conservation of animals such as bats.

W. Hardy ESHBAUGH, Department of Botany, Miami University, Oxford, OH

KEEPERS OF THE FOREST

Keepers of the Forest examines agriculture and forestry practices as well as settlement patterns among the Lacandon Maya in Chiapas, Mexico and their effect on the tropical rainforest. The film is a major contribution in the area of conservation biology and provides an overview of what an indigenous people's knowledge of the rainforest and specific agricultural techniques can teach us about the management of one of the earth's most fragile ecosystems. Norman Lippman produced this 28 minute VHS video tape that is distributed by Umbrella Films, Brookline, MA. W. Hardy Eshbaugh wrote the accompanying study guide.

Suzanne K. FISH and Paul R. FISH, Arizona State Museum, University of Arizona, Tucson, AZ

REGIONAL AND ECONOMIC CONTEXTS OF HOHOKAM AGAVE CULTIVATION

A new appreciation of the scale of agave cultivation by the prehistoric Hohokam in southern Arizona has emerged from a substantial body of recent archaeological work. Environmental variability across Hohokam territory appears to correlate with aspects of variability in technological and organizational parameters of production. Large scale distributions of farming methods and settlement suggest that Hohokam agave cultivation can be understood within a framework of economic decision-making and alternative opportunities.

Suzanne K. FISH and Thomas SHERIDAN, Arizona State Museum, University of Arizona, Tucson, AZ

FARMING IN CURCURPE: A CONVERSATION WITH ADALBERTO CRUZ

Most small scale farmers in Curcurpe, Sonora, Mexico, follow a traditional agricultural strategy that combines riverine irrigation, runoff, plantings in arroyos, and cattle grazing on communal lands. The life of a farmer is revealed through conservation between Adalberto Cruz and anthropologist Thomas Sheridan, whose research in the area spans more than 10 years. Interspersed with this conversation are views of the setting and agricultural technology. We learn how such traditional farmers cope with their environment, neighbors, and the larger world.

Arlene FRADKIN, Florida Museum of Natural History, Gainesville, FL
COMBINING FOLK BIOLOGICAL AND ZOOARCHAEOLOGICAL STUDIES: A METHODOLOGY

Folk biological studies of past human populations involve an examination of linguistic, oral tradition, and ethnographic/historical data recorded in early written sources. Reconstruction of animal semantic domains is carried out in four analytical stages: nomenclature, cultural significance, classification, and synthesis. Results from these analyses can serve as a basis for developing implications pertaining to zooarchaeological studies. Examples from the animal semantic domain of the protohistoric Cherokee Indians of the Southeast United States are used to demonstrate the application of the methodology.

Leslie M. Johnson GOTTESFELD, GCON, Kitwanga, British Columbia
ABORIGINAL USE OF BARK PRODUCTS IN NORTHWESTERN BRITISH COLUMBIA

The landscape of northwestern British Columbia is largely covered with conifer forests. Bark products were used to fill many needs which in less heavily forested environments were filled by herbaceous plants. The products of the bark of woody shrubs and trees formed an important part of the aboriginal economies of the Gitksan, Wet'suwet'en and Haisla people until the early twentieth century. Bark from woody shrubs and trees was used for nutrition, healing, fibre, and structural material. Cambium from western hemlock and lodgepole pine were important carbohydrate sources. In coastal areas, black cottonwood and amabilis fir cambium were also eaten. Bark and cambium from a wide variety of trees and shrubs were used for medicinal decoctions and as poultices. Cedar bark and willow bark were the most important sources of fibre and cordage. At the present time, most of the products formerly derived from the barks of woody shrubs and trees have been replaced with manufactured and agricultural products. To a small extent bark and cambium products continue to be gathered and utilized, especially for medicine. The most important bark product presently utilized is devil's club inner bark.

William GREEN, Office of the State Archaeologist, University of Iowa
CENTRAL PLAINS TRADITION PLANT AND ANIMAL USE: ANALYSIS OF A NEBRASKA PHASE EARTHLODGE IN WESTERN IOWA

The Glenwood "culture" of the Nebraska phase is a unit of the Central Plains tradition that is located east of the Missouri River. Glenwood communities are characterized by dispersed earthlodges situated within the highly dissected Loess Hills landform region adjacent to the Missouri River Valley. The excavation of the Wall Ridge site (13ML176) was the first at which Glenwood soil samples were systematically and stratigraphically collected and processed through flotation (0.425 mm mesh). The site therefore offers the first opportunity for a comprehensive assessment of Nebraska phase subsistence practices. Native cultigens

(e.g., *Hordeum pusillum)* and wild fruits (e.g., *Sambucus canadensis)* supplemented maize; mussels and large numbers of fish were collected from all nearby aquatic zones; and a wide range of mammals provided much of the household's food supply. Comparisons with coeval Central Plains, Initial Middle Missouri, and Oneota economic systems suggest that Glenwood people maintained Eastern Woodlands-like subsistence behaviors as a major element of their successful, long-lived adjustment to their distinctive habitat.

Eusebio HERNANDEZ RAMON, Direccion General de Culturas Populares, Unidad Regional Oaxaca, Mexico

A PHARMACOPOEIA AND FOOD SURVEY OF CHINANTLA ALTA, OAXACA, MEXICO

This is a study of the medicines and foods used by the Chinantec people in the community of La Esperanza, Comaltepec in the Northern Sierras of Oaxaca. More than 30 recipes are described as part of the diet of this particular ethno-culinary group. The relationship of the culture to the natural history of the sierra is reviewed.

K. Kris HIRST and Robert G. THOMPSON, Office of the State Archaeologist, University of Iowa

SHELL GAMES: SILICA DEPOSITS ON NAIAD SHELL CORN SHELLERS

Ethnographic evidence of the use of freshwater naiad shells for the removal of corn kernels from cobs prior to drying and storage has been documented for several historic American Indian groups, including Algonkian, Siouan, and Caddoan speakers. Formal analogues to such tools have been found in archaeological collections from central plains earthlodge sites. Opal phytoliths and amorphous mineral deposits resulting from the processing of plant material have been found on these artifacts. Similar deposits have been produced on experimental naiad shell implements used to remove corn kernels.

Phyllis HOGAN, Executive Director/Founder and Theresa BOONE, Education Coordinator
Arizona Ethnobotanical Research Association, Flagstaff, AZ

ETHNOBOTANY AND BILINGUAL EDUCATION

In remote and inaccessible areas of Indian reservations in Arizona, the Arizona Ethnobotanical Research Association has documented hundreds of beneficial plants. We will discuss the origin of the A.E.R.A. and our role in environmental education as it pertains to ethnobotany. As educators, we have incorporated ethnobotany projects into a multidisciplinary approach to cultural heritage preservation in elementary and secondary schools. By utilizing the outdoor environment as a classroom, the A.E.R.A. program emphasizes the students' culture and community as the laboratory of learning. Developing herbaria for students and teachers is done with the assistance of venerated tribal elders.

Eugene HUNN, University of Washington, Seattle, WA
HOW SIZE CONSTRAINS THE RECOGNITON OF FOLK BIOLOGICAL DATA

Constraints governing the recognition of basic level biological taxa in folk classifications have been characterized as either "perceptual" or "cultural." I suggest here that the perceptual salience of taxa involves two independent factors, phenotypic salience and size, while cultural salience involves ecological and other cultural factors. I evaluate the significance of size by plotting the average length/height (scaled logarithmically) of organisms of various sampling units against the scientific species recognition ratio (SSRR) for each such unit within a domain. Results from more than 20 domains representing some ten languages show weak to very strong positive correlations. Scatterplots for each domain clearly highlight "deviant" sampling units that require special attention to ecological and cultural factors. Reasons for the variation in correlation strength between these two variables is discussed.

Steven R. JAMES, Department of Anthropology, Arizona State University, Tempe, AZ
COMMENTS ON BUTCHERING STRATEGIES AND MEAT WEIGHT ESTIMATES USING EXAMPLES OF PREHISTORIC HOHOKAM HUNTING PATTERNS: WHERE'S THE BEEF?

Meat weight calculations and butchering strategies from ethnoarchaeological studies are reassessed in order to demonstrate how these data can be utilized for more accurately estimating protein-intake in prehistoric diets. In particular, Binford's Modified General Utility Index (MGUI) and a revised measure recently suggest by Metcalfe and Jones, that of the Food Utility Index (FUI), are evaluated and shown to be problematic. Modifications in these indices are used to examine butchering strategies and derive meat estimates for artiodactyl skeletal elements from several prehistoric Hohokam (ca. A.D. 700–1150) farmsteads and villages in the Sonoran Desert of southern Arizona.

Janice JUTILA, Brigham Young University, Provo, UT
ON ETHNOBOTANY OF RYUKYU ISLANDS

The Ryukyu islands, the southern-most islands of Japan, have a culture and language which differs from that of mainland Japan. In Okinawa, the largest island of the Ryukyu, medicinal plants and products are sold in open markets as well as in small family businesses and even in pharmacies. In the more recent history of Okinawa, specifically during World War II many Okinawans sought refuge in Taiwan. Medical provisions were scarce and many had to rely on plants for their medical care. Today, medicinal plants continue to be used by many Okinawan households.

Kelly KINDSCHER, University of Kansas, Lawrence, KS
MEDICINAL PLANTS USED BY INDIANS OF THE PRAIRIE BIOREGION

The ethnobotanical, anthropological, phharmacological, and historical literature of the Prairie Bioregion of North America was searched for references to the use of medicinal plants by the Indian tribes of the region. This search has resulted in finding that 20 tribes used 165 species of native plants for medicinal purposes. These tribes include the Lakota, Omaha, Comanche, Meskwaki, Kowa, and others, Representative ailments treated by each species are listed. This study is intended to encourage further ethnobotanical study in the region and the preservation, conservation, and restoration of native prairie remnants.

Frances B. KING, University of Pittsburgh, Pittsburgh, PA
POTENTIAL NATIVE CULTIGEN FROM A SITE IN EAST-CENTRAL PENNSYLVANIA

Current evidence suggests that native North American seed crops were grown primarily from Ohio westward. However, the Catawissa site (36Co9) in the Susquehanna River Valley in East-Central Pennsylvania yielded numerous carbonized seeds that appear to be wild barley *(Hordeum pusilum),* along with many other taxa, from features ranging in age from approximately A.D. 500 to A.D. 1100. Maize, beans, and squash are also present in younger features although several other cultigens, potential cultigens, and domesticates are absent. Wild barley is not native to Pennsylvania and its presence in this site suggests that it may have been filling a role similar to that of maygrass *(Phalaris caroliniana)* in portions of the Midwest.

Joseph E. LAFERRIERE, Charles W. WEBER, and Edwin A. KOHLHEPP, University of Arizona, Tucson, AZ
NUTRITIONAL VALUE OF MOUNTAIN PIMA FOOD PLANTS

Selected foods of plant origin consumed as food by the Mountain Pima of Chihuahua, Mexico, were analyzed for proximate and mineral nutritional content. Fruits of *Prunus gentryi, P. serotina* var. *virens, Berberis pimana, Jaltomata procumbens, Opuntia* spp., *Arctostaphylos pungens,* and *Arbutus xalapensis;* roots of *Prionosciadium townsendii;* tubers of *Dahlia coccinea;* bulbs of *Hymenocallis pimana;* flowering stalks and leaf bases of *Agave shrevei;* inflorescences of *Tillandsia erubescens;* and immature cladodes of *Opuntia* spp. were analyzed for proximate and mineral composition. Subterranean organs in general proved high in carbohydrat while fruits were high in fiber. The tree species of *Opuntia* varied considerably in composition although all were high in carbohydrates, fiber, calcium, and magnesium. Mineral contributions of native teas made from shoots of *Tagetes lucida, T. filifolia, Holodiscus dumosus,* and *Elytraria imbricata,* and from root xylem of *Ceanothus depressus* and *Phaseolus ritensis* were also investigated; both the plant material and the watery infuson were analyzed. Results indicate that varying amounts of mineral diffused from the plant material into the aqueous solution. Three condiments were also analyzed for mineral content, i.e. *Monarda austromontana, Hedeoma patens,* and *Teloxys abrosioides.*

Edelmira LINARES and Robert BYE, Jardín Botánico, Universidad Nacional Autónoma de México, México, DF

FUNDAMENTAL PLANTS USED IN THE TREATMENT OF FOUR ILLNESS CATEGORIES IN MEXICO

In order to determine the plants used most frequently in a treatment of four major illness categories (cardiovascular, gastrointestinal, renal [& associated female disorders], & diabetic), various markets of Mexico were studied. In each case, the herbal mixtures contain a fundamental set of medicinal plants as well as various additive depending upon the condition of the patient. Based upon a traditional concept of health, satellite ailments are associated with each principal illness and are treated collaterally. The fundamental plants for each illness category include: cardiovascular: *Citrus*, Ternstroemia, Haematoxylum, Agastache, Chiranthodendron, Ipomoea, Valeriana, Taxodium, Juglans;* gastrointestinal: *Marrubium*, Hippocratea, Miatonia, Matricaria*;* renal: *Equisetum, Arctostaphylos, Guazuma, Crataegus, Cyatheaccae,* sensulato; diabetic: *Tecoma, Cecropia.* (* = introduced taxa).

Daniel LOPEZ, Sells, AZ

***MELHOG:* DESERT PLANT OF MANY USES**

Melhog (ocotillo, *Fouquieria splendens)* is an important plant for the Tohono O'Odham tribe of southern Arizona and Sonora, Mexico. The use of the plant for food, shelter, medicine, and ceremonies is a long-standing tradition on the reservation. Beyond its utilitarian purposes, *melhog* has a rich history in folklore among the O'Odham. Curing songs of the medicinemen feature *melhog,* and its use in their most sacred ceremony—children's shrine renewal—has ancient origins. The Tohono O'Odham attitude toward *melhog* typifies their respect for all living things.

The significance of *melhog* in the Tohono O'Odham culture will be discussed in terms of its utilitarian uses, its place in folklore, and its symbolism of the respect for nature that is an underlying premise of the O'Odham way of life.

Guadalupe MALDA and Humberto SUZAN, Instituto de Ecologias y Alimentos, Universidad Autonoma de Tamaulipas

CONSERVATION OF RARE WILD PLANTS IN JAUMAVE TAMAULIPAS

Habitat destruction and over collection of rare wild plants are the major problems for conservation of endangered and threatened cacti; in several cases those endangered speices are also useful as food or medicine. Because the involvement of rural communities seems the only viable solution for the rescue and *in situ* conservation of those species, the creation of rural nurseries in cooperation with the people was developed as an option for conservation and management of these resources. An exemplary program at Jaumave Valley is presented. The program includes research in the following fields: environmental education; ethnobotanical studies; micro and macropropagation; germination response studies; and a demographic plant monitoring study for selected species. Progress in each, over the last three years is summarized.

D.B.S. MAXWELL, Department of Anthropology, University of Arizona, Tucson, AZ

SUGGESTIONS FOR FUTURE RESEARCH IN THE DETERMINATION OF SEASON OF COLLECTION OF MARINE BIVALVES

Modern comparative collections have come to be an essential part of season of collection (seasonality) studies which deal with shellfish. However, collections are usually compiled in haphazard fashion. This paper is intended to provide a means of standardization. Strategies for compiling modern comparative collections will be offered, including methods for sampling and examining small-scale regional variation. Suggestions will be made regarding size ranges of animals useful for study, based on a pilot study of time involved in specimen preparation, and rates of fracturing during specimen preparation.

Brien MEILLEUR, Bishop Museum, Captain Cook, HI, and
Vincent LEBOT and Richard MANSHARDT, University of Hawaii at Manoa.

THE HAWAIIAN CULTIVARS PROJECT

Fundamental features of traditional Hawaiian culture and agriculture, the cultivated varieties of banana, bottle gourd, kava, sugar cane, sweet potato, taro and yam represent potentially key data in the study of the Polynesian adaptation to the ecologically diverse Hawaiian archipelago. Last significantly investigated over 50 years ago, the Hawaiian cultivars have been under-utilized in recent work on Hawaiian human ecology because of poor linkages between published ethnographic, linguistic and agronomic information and the living material itself. This paper will describe several experimental methods for establishing accurate links between Hawaiian cultivars and existing ethnographic information, regrettably, something only a handful of Hawaiians are now able to do. We will present preliminary laboratory results from isozyme electrophoresis as applied to three Hawaiian crops: banana, kava, and taro. This, and complimentary characterization techniques, when combined with ethnographic analysis, should lead to resolution of much present confusion in Hawaiian cultivar uses and naming, and potentially to improved understanding of intraspecfic crop diversity in Polynesian adaptive processes.

Richard Alan MILLER, Northwest Botanicals, Inc., Grants Pass, OR

NATIVE PLANTS OF COMMERCIAL IMPORTANCE

Among the wild plants of North America are many which have long been used in the medicinal, cosmetic, food, and floral industries. Some of them are used in sufficient quantities to make them commercially important. The collection of plants or plant parts for these markets has long provided gainful employment for many people living in the rural sections of the United States. A book has been prepared to describe these and other forest products, dividing the United States into five regions: Northeast, South, Midwest, Southwest, and the Northwest. Detail in marketing is described. Each region contains a description of ten

common crops now harvested, with suggestions on additional crops which might have markets developed in the next several years. Reforestation is stressed to make each crop renewable and self-generating as a natural resource. This technique has led to the new concepts of forest farming. The future of foraging as a source of supplementing one's rural income lies with our ability to recognize natural resources.

Felipe S. MOLINA, Yaqui Family Literacy Program, Tucson, AZ,
Richard S. FELGER, Drylands Institute, Tucson, AZ and
William B. STEEN, Elgin, AZ

PLANTS AND ANIMALS IN YOEME RELIGIOUS CELEBRATIONS: EDUCATIONAL GOALS

Numerous plants and animals form an integral part of Yoeme (Yaqui) religious celebrations, both in Arizona and Sonora. Many Yoeme have great respect for the plants and animals in the *Huya Ania* (wilderness world) because each plant and animal has a *hiapsi* (soul or heart), so that is why they are a part of the ceremony. Although many adult and young people have gaps in traditional knowledge, they show a strong interest in learning about plants and animals in Yoeme ceremonies. A major topic often voiced at community meetings is concern over loss of traditional information. Our project addresses this concern by assisting in the development of classroom curriculum materials, in both Yoeme and English, and ultimately in presenting the information in usable printed form.

Felix MORALES P., Direccion General de Culturas Populares, Unidad Regional Oaxaca, Mexico

THE TECHNOLOGY OF TRADITIONAL AGRICULTURE IN SAN CRISTOBAL LACHIROAG, OAXACA, MEXICO

In this work we describe and record the Zapotec technology and the tools used in traditional agriculture. In the same time we are looking at the customs that involve cultivating plants; how the myths, costumes, and other factors may affect the activities of these people as well as how these traditional ways can be encouraged and promoted. This is also an account of the natural resources and land improvements both in the past and today. We also include the times of abundance and the economic implications of these seasonal fluxes.

F. David MULCAHY, Polytechnic University, Brooklyn, NY

RARE MEDICINAL USES OF *GLYCYRRHIZA GLABRA*

Glycyrrhiza glabra or Mediterranean licorice is one of the most ancient and widely used Old World medicinal plants. Today, as in antiquity, it is usually prescribed as an expectorant, respiratory demulcent and flavoring agent for other medications. Some of the less frequent medical uses of the plant will be documented from a variety of ancient and modern materia medica. These uses will be discussed in light of recent pharmacological studies of the plant.

Luz Ma. Mera OVANDO, Elia HERRERA TORRALBA, Robert BYE, Miguel Angel MARTINEZ ALFARO and Francisco BASURTO PENA, Jardín Botánico, Universidad Nacional Autónoma de México, México, DF

ETHNOBOTANY AS AN INTERACTIVE COMPONENT IN INTER-DISCIPLINARY STUDIES OF GENETIC DIVERSITY IN BEANS *(PHASEOLUS,* FABACEAE) OF MEXICO

Most of the species of the New World genus *Phaseolus* (frijol) are concentrated in Mesoamerica. Over 90% of the wild species and the four principal domesticated species (*P. acutifolius* Gray, *P. coccineus* L., *P. lunatus* L., and *P. vulgaris* L.) are native to Mexico. The genotypic variation that has been produced over thousands of years through natural selection, domestication, adaptation to ecological niches of differenct production regions, and varying cultural preferences related to consumption qualities must be evaluated through interdisciplinary studies with common global objectives. Ethnobotany, taxonomy, genetics and ecophysiology are complements of our current research program on the genetic diversity of Mexican wild and domesticated beans. Preliminary results from studies of different subspecies of *P. coccineus* (scarlet runner bean, ayocote, tekomari) from the Sierra Norte de Puelba (Puebla) and Sierra Tarahumara (Chihuahua) are presented.

Kristina PETERSEN, Brigham Young University, Provo, UT

THE DUTCH MONOPOLY OF NUTMEG

In the mid 17th century, the Dutch East Indies Company established a monopoly on the nutmeg tree, *Myristica fragrans,* which was world renown as the source of the highest quality nutmeg. For approximately 150 years, they successfully controlled the trade of this important spice by restricting the growth of this nutmeg species to two islands, Ambon and Banda, located in the Moluccas. The monopoly was finally broken in the late 18th century when an inferior nutmeg was successfully substituted and traded in place of *M. fragrans* which resulted in the ultimate bankruptcy of the company. *M. fragrans* is still grown on Ambon and Banda and is exported for use as a spice, a preservative and, in some cultures as a drug.

Gayle POTTER-BASSO, Heber, AZ

A PLANT FOR ALL SEASONS: *YUCCA BACCATA* IN WESTERN APACHE CULTURE

The Western Apache of Arizona have incorporated *Y. baccata* into almost every area of their culture. This plant is utilized in a host of ways, from a form of dental floss to an active agent in returning celestial bodies to their correct positions following eclipses. In addition, it may be employed as food, soap, paint, and rope; it holds cradleboards and homes together; it protects people and horses from sickness and misfortune. This paper, which is based on current ethnographic research in a community on the Fort Apache Reservation, and also incorporates materials gathered in the 1930s will demonstrate that Western Apache history, ideology, and society are all symbolically ''present'' in this type of yucca.

Karl J. REINHARD, University of Nebraska, Lincoln, NE
POLLEN CONCENTRATION AND COPROLITES: AN APPROACH TO PALEOPHARMACOLOGY

Over 2,000 plant species have been documented ethnographically as having medicinal value among Native Americans. It is, therefore, not surprising that evidence of medicinal plants appears in some of the 1,000 coprolites studied in the southwestern U.S. Pollen concentration is an especially useful technique in identifying use of medicinal "teas." Concentration values (# grains/gram) of coprolites clearly distinguish intentional ingestion of polleniferous materials from unintentional ingestion of ambient pollen.

Three species are discussed. Willow *(Salix)* is the most common analgesic in the Native American pharmacopoeia of coprolites from Bighorn Cave in the Black Mountains of Arizona, and also in a burial from the Mimbres Valley, New Mexico. Mormon tea *(Ephedra)* was used historically as a diuretic, and evidence of its prehistoric use is also present in Bighorn Cave. Creosote *(Larrea)* is an antidiarrheal plant, and evidence of its use has been documented as Caldwell Cave in far western Texas. These remains demonstrate the aniquity of folk remedies, and provide circumstantial evidence of certain disorders suffered by prehistoric peoples.

Elizabeth J. REITZ, Museum of Natural History, University of Georgia, Athens, GA
PATTERNS OF VERTEBRATE USE DURING THE ARCHAIC PERIOD IN PERU

Data from three Archaic sites on the coast of Peru demonstrate that marine vertebrates constituted a substantial portion of the animal-based diet. Marine animals, particularly herrings, anchovies, and pinnipeds, were major resources from 8000 B.C. until at least 3000 B.C. In collections from Carrizal, the Ring Site, and Paloma, marine vertebrates constituted over 90% of the individuals. Marine resources were clearly important in the economies of these early sites.

Beatriz RENDON AGUILAR and Robert BYE, Jardin Botanico, Universidad Nacional Autonoma de Mexico, Mexico, DF
AN ANALYSIS OF TWO INTRODUCED SPECIES IN TRADITIONAL MEXICAN AGRICULTURE: ROSELLE *(HIBISCUS SABDARIFFA* L., MALVACEAE) AND COFFEE *(COFFEE ARABICA* L., RUBIACEAE)

Roselle (jamaica) and coffee (cafe), both African species introduced into Mexico at different times, have adapted to the traditional agriculture and subsistence of the Mexican people. Two studies developed in the state of Guerrero examine these species as components of traditional intercropping agricultural systems. Roselle is grown annually in the polyculture maize fields of the lower deciduous tropical forest. Coffee forms a perennial component of the shrub stratum of the intermediate subdeciduous tropical forests. These management

systems have many ecological and economic advantages from the farmers' viewpoint. Ecologically, they allow *in situ* resource conservation. Economically, they provide a safeguard against losses due to price fluctuation of the products in the national market.

Maricela RODRIGUEZ-ACOSTA and Martha LINARES,
Universidad Autonoma de Puebla, Mexico, Puebla, Pue., Mexico
STUDY OF THE USEFUL FLORA FROM THE MUNICIPALITY OF TECALI DE HERRERA, PUEBLA, MEXICO

This study is part of the project "Useful flora from the states of Puebla and Tlaxcala," in Mexico. The municipality of Tecali de Herrera is located southeast from the city of Puebla with an altitude of approximately 2,100 meters above the level of the sea. It has a humid and temperate weather with summer rains and a prominent calcareous soil. The vegetation includes xerophytic bushes and some regions with oak woods. There, 232 different species were found. From these, 190 are used in 24 categories. The most important uses are: forage, fuel, food, ornamental, building materials, alive fences, melliferous, work instruments, shadow and condiment. Medicinal plants are employed for 70 therapeutic uses. The use of the flora is considered to be very high in the area of study, since only 39 species out of 190 are cultured, while the rest correspond to the wild flora.

Guenter ROSE and Anne BOETTCHER, Bowdoin College, Brunswick, ME
THE EFFECT OF *SOLANUM NIGRUM* ON SLEEP-AWAKE EEG, VISUAL EVOKED POTENTIALS, AND BEHAVIOR IN RATS

Solanum nigrum has many indigenous medicinal uses worldwide, some of which, as in the treatment of pain, involve the CNS. In Sri Lanka it is used as a folk remedy to reduce nightmares, especially in children. This preliminary study demonstrated significant changes in both neurophysiological and behavioral parameters as a function of plant extract dosage.

In normals and control (sterile water) rats, the percentage of awake versus sleep EEG was 20–25% and 75–80% respectively, with the majority of totol recording time (3 hours) spent in slow wave sleep (55–60%). During sleep, time spent in SWS versus REM was 77% versus 22%. Depending on dosage, intraperitoneal injection of extract shifted percent time to 100% wakefulness at high doses (1.0 gm/kg), to lower percentages at lower doses accompanied by emerging SWS, but continued REM suppression. Whereas most of the EEG during normal wakefulness was the alert type (65–75%), in experimentals this shifted to quiet awake EEG (maximum of 88%), accompanied by depression of behavioral activity, and evoked potential waveform changes.

Roy A. SALLS, California State Univeristy, Northridge, CA
ZOOARCHAEOLOGY OF THE SECRET TOLACHE CULT RITUALS

Zooarchaeological research applied to the ethnographical data of the Indians of Southern California has revealed that much of the information obtained by ethnographers on the prehistoric Indian culture is hopelessly mixed with that

of the Indians of northwest Mexico as well as being influenced by European value standards. Recent faunal evidence from San Clemente Island, California appears closer to the Spanish chronicles than it does the early 20th century ethnographies of the "Eagle Ceremony." The most intriguing aspect of the faunal data is ritual canid dismemberment utilizing dogs and foxes in the same manner as the birds in the so-called Eagle Ceremony. Evidence for the canid ceremony can be found throughout Southern California dating back possibly to 9000 B.C. but only recently recognized as an important ritual. Even more important is that this ceremony has never been recorded and is either unknown to living ancestors or has been their most successfully kept secret.

Silvia SANTAELLA and Estela ZARATE, D.G.C.P., Unidad Regional Oaxaca, Oaxaca, Mexico

BREEDING SILKWORMS *BOMBYX MORE* L. IN THE NORTHERN SIERRAS OF OAXACA, MEXICO

In this work we present data to show the breeding of the silkworm *Bombyx mori* L. in the Cajonos region of the Northern Sierras of Oaxaca. We discuss the life cycle, the community size studied as well as the preparation of the silk and manufacture of the cloth.

Ulrike SCHACHT and Michael EILBRECHT, Technical University of Berlin, West Germany

A THEORY FOR DEVELOPING A NATURAL METHOD OF LANDSCAPE PLANNING

The connection between using natural resources, limitations and traditions can be demonstrated as a foundation for generating a natural method of landscape planning as exemplified by the Chatinos, an indigenous folk in the Sierra Madre del Sur of Oaxaca, Mexico.

Brian S. SHAFFER, Texas A&M University, College Station, TX

QUARTER-INCH SCREENING: UNDERSTANDING BIASES IN RECOVERY OF FAUNAL REMAINS TO AUGMENT ZOOARCHAEOLOGICAL INTERPRETATION

Fine-screening of archaeological materials has often proven to be too expensive and too time consuming for large assemblages and so ¼" has become the standard size of mesh to use. Unfortunately, little work has been conducted in documenting the effects of ¼" screening on bone recovery and the resulting biases in interpretations that may result. Previous research indicates that ¼" screening does bias sample recovery, but this research has not documented the biases in recovery and loss of specific elements for specific taxa. To better understand these biases, tests were conducted on 24 species of modern mammals. Results of these tests indicate that recovery and loss of specific elements for each taxon can be anticipated. Provided with this information, the zooarchaeologist can better understand the composition of the assemblage being analyzed and will therefore be better prepared to interpret the data.

G.K. SHARMA, University of Tennessee, Martin, TN
ENVIRONMENTAL POLLUTION: A TRAGEDY IN SHANGRI-LA

The Himalayas, extending from Afghanistan to Burma, represent a delicate ecological complex with connotations of an idyllic retreat for human spirit and contemplative asceticism. Environmental pollution, deforestation, and agricultural practices have greatly disturbed the ecological balance of this fragile ecosystem. The burning of fossil fuel in the plains of the adjoining areas has contributed to the particulate and gaseous contamination of this pristine habitat. The vegetation, human health and resources, and lifestyle of the local inhabitants have been affected. Some of the rare plant species of the area are endangered. Cereal crops have reduced yields and in the absence of proper direction, the local inhabitants have started migrating to the plains of the neighboring states. This exodus has affected the folklore and ethnobotanical knowledge so critical to the economic and medicinal treasure-trove of the area. Research was funded by the Rotary International and the University of Tennessee, Martin, Tennessee.

Wade C. SHERBROOKE, Southwestern Research Station, American Museum of Natural History, Portal, AZ
HORNED LIZARDS: RECURRENT IMAGES FROM SOUTHWESTERN PEOPLES

Images representing horned lizards (''horny toads;'' genus *Phrynosoma)* have been used for centuries by successive culture groups occupying the western United States and Mexico—the only region in which these unique lizards occur. Their representational use by Anasazi, Hohokam, Mogollon, and Casa Grande cultures is illustrated. Information from the archaeological record is being compiled from museum collections and from published reports. Published ethnographic reports are being examined for references to horned lizards; these came from diverse cultures, including Navajo, Piman, and Zuni. Modern crafts of Native American and other Southwestern artists that incorporate horned lizard designs are displayed. These demonstrate the continuing multicultural fascination that these creatures have aroused amongst inhabitants of the Southwest.

Shawn SIGSTEDT, Harvard University, Cambridge, MA
THE PROTECTION OF INDIGENOUS CULTURES BY THE PRESERVATION OF ECOSYSTEMS

Today there is widespread recognition for the need to maintain wilderness areas and natural ecosystems by the preservation of lands, organisms, and processes of evolutionary change. There is also a growing recognition for the need to maintain natural ecosystems for the protection of indigenous cultures. Throughout the world concerns are being voiced by indigenous people for the preservation of their historical, ethnobiological, and medicinal plant heritage by the protection of the natural ecosystems through which their cultures emerged by the formation of parks where sustainable harvest of natural products may continue into perpetuity. Many of these cultural lands and ecosystems are being

threatened by rapid development and habitat destruction due to economic incentives for short term gain. Over participation in new market economies include high risks that indigenous cultures will lose their knowledge and traditions. Such traditions are often based on results of centuries of accumulated observations, and extended experimentation by these isolated "island-like" cultures within their diverse ecological communities. In the larger view we all run the risk of losing our global heritage of the diversity of human cultures, and the organisms they evolved with, as a result of these losses of biological diversity.

Shawn SIGSTEDT, Harvard University, Cambridge, MA
BEAR MEDICINE: "SELF-MEDICATION" BY ANIMALS

There is growing evidence that medicinal plants may be used by animals. Observations suggesting "self-medication" by animals have brought into speculation a potential role of animals in the human discovery of medicinal plants. In this paper, the medicinal plant *Ligusticum porteri,* (Osha', Bear Medicine, Na'Bi), is examined to investigate a possible relationship between humans and animals in the discovery of medicinal plants. American Indian legends are discussed which tell that this medicinal plant, *Ligusticum porteri,* was originally a gift from the Bear to the human beings for use as medicine. Present captive-bred bear observations suggest a biological basis for such legends. Recommendations for the protection of historical lands and natural ecosystems hosting these organism and medicinal plants, and ultimately for the preservation of human cultures, are discussed.

Daniela SOLERI, Seeds/SEARCH, Tucson, AZ
A PRELIMINARY SURVEY OF HOPI CROP REPERTOIRES AND IMPLICATIONS FOR IN SITU CONSERVATION OF CROP GENETIC RESOURCES

A preliminary survey of the crop repertoires of 50 Hopi farmers found abandonment of some traditional or folk varieties, however a large number of folk varieties are still grown and comprise the majority of crop varieties in those farmer's repertoires. Retention of Hopi folk varieties or adoption of new, non-Hopi varieties was observed to vary both between crops and between crop varieties in ways which suggest a complex combination of cultural and environmental reasons for the composition of crop repertoires.

The findings also demonstrate that the Hopi farming system is an example of *in situ* conservation of crop genetic resources. This research and further collaborative work with knowledgable Hopi farmers could provide insights useful to supporting these and other farmers' and communities' efforts to conserve their crop genetic heritage in ways which they see as appropriate and useful.

Carlos Solorzano TELLO, Aristides SUASTEGUI R., and Miguel A. MARTINEZ ALFARO, Jardin Botanico del IB-UNAM, Apdo. Postal 70-614, Coyoacan 04510, Mexico, D.F.
THE AMPHIBIANS AND REPTILES AMONG THE TOTONAC INDIANS OF HUEHUETLA, PUEBLA, MEXICO

Despite the ecological deterioration in the Sierra Norte de Puebla, the Totonac Indians of Huehuetla maintain a broad knowledge of the local flora and fauna

and, hence, have a rich biological perception of their environment. The Totonac biological universe consists of several parts that are strongly integrated and in continuous motion. Natural ethnotaxa include chichakys *(Anura),* xcolulo *(Lacertidae),* kagayam (turtles), sarampitpit (salamanders), Luwua (snakes and certain arthropods and mollusks). These animals are important as mythological elements in Totanac cosmovision. Information derived from field work demonstrate their role in economic utility, ecological degradation and environmental integration. Because of the socioeconomic marginality of indigenous groups, the Totonac people are undergoing transculturation thus provoking changes in their concepts of fauna by incorporating western elements.

Ellen SPEISER and Dominique IRVINE, Cultural Survival Inc., Menlo Park, CA
RUNA: GUARDIANS OF THE FOREST

Runa: Guardians of the Forest centers on a single community of Runa (lowland Quichua) Indians in the Loreto area of the Ecuadorian Amazon. The film portrays both sides of their life at present: the traditional knowledge and practices that form the core of their adaptation to the rainforest, and their reactions and adjustments to the larger society, which is quickly impinging on their community. The profound ecological knowledge of native peoples like the Runa offers hope for a successful adaptation to the rainforest in the future. This message is conveyed by the Runa themselves, who contributed to and guided the filming. The film depicts the complete cycle of forest use and management practiced by the Runa ranging from the planting of crops in swidden agricultural plots to the protection and planting of trees in managed fallows to the use of tree species found in mature forests. Game management and the protection of fishery resources are also illustrated.

Aristides SUASTEGU, Carlos GONZALEZ and Miguel A. MARTINEZ, Jardin Botanico, Universidad Nacional Autonoma de Mexico, Mexico, DF
ETHNOZOOLOGICAL NOTES ON TOTONACS FROM HUEHUETLA, PUEBLA, MEXICO

The Totonac Indians of Huehuetla, Puebla, have a strong knowledge on the regional fauna. In this paper we show information on herpetological aspects (frogs, toads, snakes, and salamanders). This ethnic group has many myths about these animals. Several symbols in relation with the cultural origins are an important source on the nature's perception. This paper shows such vinculation between the natural and culture across the oral history in a town with such traditions. The town is isolated and only is reached by animal transport or walking.

Mark TAPER, Department of Biology, University of New Mexico, Albuquerque, NM and **Christine FRANQUEMONT,** Department of Anthropology, Cornell University, Ithaca, NY.
MUSHI NO HI, THE DAY OF THE INSECT
THE FUNCTION OF RITUAL IN JAPANESE BIOLOGY

The government of Japan has built a new Science City at Tsukuba to encourage scientific research and development. At a government research institute on

environmental sciences, the annual Mushi No Hi ritual is held to honor the souls of the insects sacrificed to science during the preceding year. The authors investigated the context of this ritual and researchers' beliefs about it. Variation in the accounts given show that the ritual serves multiple social and scientific functions beyond religious meaning. As a social event bringing together scientists in a single discipline from the entire range of institutions of the area, the ritual disrupts the rigid system of institutional parallelism characteristic of Japanese society. The dedication of a stone monument established a senior/junior relationship for this new, seemingly orphan institute. The event demonstrates that the need for traditions leads the scientists in the new city to emphasize and invent a tradition tying them into the religious and scientific history of Japan.

Jan TIMBROOK, Santa Barbara Museum of Natural History, Santa Barbara, CA
USE OF *YUCCA WHIPPLEI* BY THE SOUTHERN CALIFORNIA INDIANS

The chaparral yucca or Spanish bayonet, *Yucca whipplei,* occurs in the coastal mountains of southern California and inland to the margins of the Mojave Desert. Several Native American peoples made considerable use of this plant, particularly as a source of food. Although in some ways it might be regarded as an agave equivalent, yucca had its own distinctive patterns of usage and classification. This paper surveys use of *Yucca whipplei* by the various Indian groups in whose territory it occurs, with particular attention to the Chumash. Possibly indicating its cultural significance, Chumashan languages have extensive terminology for different parts of the plant in raw, cooked, fresh and dry states.

Mollie S. TOLL and Pamela MCBRIDE, Department of Biology, University of New Mexico, Albuquerque, NM
OPPORTUNITIES FOR INVESTIGATING BROAD-SCALE PATTERNS OF HUMAN IMPACT ON THE SEVILLETA LONG-TERM ECOLOGICAL RESEARCH PROJECT, SOUTHERN NEW MEXICO

A remarkable data base currently being generated for the NSF-funded Sevilleta LTER will allow integration of human impact data with environmental variables on a broad scale and level of precision heretofore only dreamed of by ethnobiologists. The distribution of archaeological sites over time and space will be included because it can provide a very specific record of human adaptive response to known paleoclimatic flux and other aspects of prehistoric and historic landscape, a record not available for any other organism. Data bases include plant demography and physiology, mammals, invertebrates, soils, hydrology, landforms, weather, and landscape characterization. Technical back-up for the Sevilleta LTER includes the GIS mapping system, digitized satellite and balloon imagery, and FTIR and LIDAR (instrumentation designed to measure the flux of biogenic gas emissions such as carbon fixation, respiration, evapotranspiration, and denitrification, over pathlengths up to 1 km). Ethnobiologists should be aware of this exceptional research opportunity in the early stages of this project, due to run 20 years or longer.

Jaime TORTORIELLO GARCIA, Biomedical Research Unit in Traditional Medicine and Drug Development, IMSS, Xochitepec, Morelos, Mexico

PHARMACOLOGICAL EVALUATION OF FOLKLORE USE OF *GALPHIMIA GLAUCA*

Aerial parts of *Galphimia glauca* commonly known as "calderona amarilla" have been for since many years in the treatment of mental disorders and as a nerve sedative in Mexican folk medicine. Four kg of dried aerial parts of the plant were collected in Dr. Mora, a town of Guanajuato, Mexico, in the fall of 1989, and extracted overnight maceration in petroleum ether, then with hexane and finally in methanol. Hexanic and methanolic extracts were tested in 4 pharmacological systems: potentiation of narcotics, in which both extracts increased pentobarbitone sleeping time; anticonvulsivant activity, in which both extracts produced a small increase in the latency of threshold convulsion, avoiding seizures and death; modification of body temperature in rats, where a significant decrease in temperature was obtained with both extracts; and electrically-stimulated guinea-pig ileum, in which dose-response curves were obtained with both extracts, producing a decrease of tissue contraction.

Nancy J. TURNER and Richard J. HEBDA, Royal British Columbia Museum, Victoria, B.C.

CHILCOTIN (TSILHQUT'IN) ETHNOBOTANY

The Chilcotin (Tsilhqut'in), an Athapaskan group of central British Columbia, retain much of their traditional economy based on hunting, fishing and gathering plants. In 1988 we undertook preliminary field interviews and literature search to document the role of plants in Chilcotin language and culture. Chilcotin elders and younger band members recognized and named about 100 different types of indigenous plants. Many plants are still used today.

Important species are: *Claytonia lanceolata* and *Erythronium grandiflorum* ("root foods"); *Pinus contorta* (inner bark eaten); *Heracleum lanatum* (green vegetable); *Amelanchier alnifolia, Fragaria virginiana, Ribes irriguum, Rubus idaeus, Shepherdia canadensis, Vaccinium caespitosum* and *V. membranaceum,* (fruits); *Ledum groenlandicum* (tea); *Veratrum viride* and *Cicuta douglasii* (toxic plants); *Betula occidentalis* (wood, bark fiber); *Juniperus scopulorum* (wood, scent, medicine); *Picea glauca* (wood, pitch source, medicine); *Populus balsamifera* (wood); *Salix* spp. (wood); *Elaeagnus commutata* (fiber); and *Urtica dioica* (medicine). Some Chilcotin plant names (e.g. "grass," "spruce") are cognate with those of distant Athapaskan languages such as Chipewyan and Navajo.

Ana Guadalupe VALENZUELA, Tequila Sauza, S.A., Guadalajara, Jalisco, Mexico

AGROECOLOGICAL INVESTIGATIONS OF THE BLUE TEQUILA AGAVE, *AGAVE TEQUILANA* WEBER

The cultivation of the blue tequila agave, *Agave tequilana* Weber, offers an important agroecological alternative in the hot zones of "Nueva Galicia" in

western Mexico. In the state of Jalisco in particular, this crop ecology system has not been given the attention it deserves from scientific investigators, perhaps due to its narrow regionality. Beginning in 1987, Tequila Sauza initiated a wide range of agroecological investigations concerning the diseases, insect ecology, fertilization responses, appropriate intercrops, and economic investments in tequila fields. Research collaboration with University of California at Los Angeles and other institutions has already yielded useful results.

Willard VAN ASDALL, University of Arizona, Tucson, AZ
ETHNOBIOLOGICAL ASPECTS OF NEW AGE HEALING: AN ALTERNATIVE MEDICINE APPROACH

In 1970, Andrew Weil published a paper which dealt with, in part, the ethnobotany of an American subculture, the "Hippie" generation. This paper looks at another emerging subclulture—those who embrace and endorse New Age principles and concepts. During the past decade or so there has been increasingly greater interest in alternative medicine and healing. Some of the modalities have been revivals and modifications of ancient healing arts and others have been formulated relatively recently. Many of the modalities include an expanded view of the human condition and many use, for example, flower essences and essential oils for redressing imbalances in the physical, mental, and emotional systems of human beings. In this paper, some of the expanded views of the human condition and selected healing modalities will be discusssed.

Luz Elena VASQUEZ DAVILA, Universidad Autonoma Benito Juarez de Oaxaca and **Marco A. VASQUEZ DAVILA,** Centro de Ecodesarrollo, A.C.
ETHNOBOTANY OF DYEING PLANTS OF THE ZAPOTECS OF OAXACA, MEXICO—I. SANTA ANA DEL VALLE.

The Zapotecs of Santa Ana del Valle (a town situated at the Northeast of Oaxaca City and at 1780 feet above the sea level) have been known by their beautiful wool rugs, dyed with natural colors. To dye the wool, the Zapotec Indians of this town employ barks, leaves, flowers, fruits or the complete plant. They gather these materials in the ecosystems near the town. This study describes the use of dyeing plants and the general process of rug weaving.

M.A. VASQUEZ-DAVILA and M.B. SOLIS-TERJO, Privada De Almendros #109, Col. Reforma, Oaxaca, Oaxaca, Mexico, C.P. 68050
ETHNOECOLOGY OF THE GREAT KISKADEE (AVES: TYRANNIDAE) IN TABASCO, MEXICO

This study was undertaken in Tabasco, situated in Southeast Mexico in the Neotropical region characterized by rain forests, grasslands, wetlands and mangroves. This paper describes that the great kiskadee *Pitangus sulphuratus* is a conspicuous organism in the diverse ecosystems and it is known very well by the Chontal Indians (of the Maya linguistic family) and by the mestizo peasants. They both respect this bird that disperses the chili pepper seed *Capsicum annum*

var. *glabriusculum*. In this study, we make an ethnoecological and linguistic analysis about the biological perception of both social groups concerned with man-animal-plant relationships.

Maria del Carmen VAZQUEZ ROJAS and Robert BYE,
Jardin Botanico, Universidad Nacional Autonoma de Mexico, Mexico, DF
ETHNOBOTANICAL ASPECTS OF PAPALOQUELITE

With the objective of documenting the importance of *Porophyllum ruderale* (Jacq.) Cass. subsp. *macrocephalum* (DC.) R.R. Johnson since the pre-Conquest period, ethnobotanical information was compiled from archaeological, historical and contemporary sources. In Mexico, various taxa of the genus *Porophyllum* are called papaloquelite. This name is derived from the Nahuatl terms ''papalo''—'butterfly' and ''quiltil''—'edible green'. The earliest available written records about the utilization of this plant are found in the 16th century codices which emphasized their medicinal and edible properties. Today, papaloquelite is employed widely as a condiment in central Mexico. *Porophyllum ruderale* subsp. *macrocephalum* in particular is involved in an active domestication process. The Mexican farmers (campesinos) intereact with this plant at different levels ranging from gathering it from wild populations to cultivating it and selecting different forms.

Michael WINKELMAN and Betsy BRANDT, Department of Anthropology,
Arizona State University, Tempe, AZ
A COMPUTER-BASED PROGRAM AND DATA BASE FOR MEDICINAL PLANTS

This paper reports on the development and use of two programs on the MacIntosh computer with the Hypercard program for ethnomedical and ethnopharmacological data. The program, developed with the technical assistance of the ASU Hispanic Research Center, provides a number of benefits in utilizing, organizing and presenting information on medicinal plants and their biochemical and pharmacological characteristics. The programs are specialized for data on: 1—traditional plant use; and 2—data on biochemical and pharmacological properties. The program is interactive and ''user-friendly'' with visual prompts or categories of information and types of responses. Program properties permit: 1—input of data from other text files; 2—searches on any aspect of the data (e.g., common or botanical plant names, ecological zone, plant use, pharmacological properties, biochemical constituents, etc.); and 3—selective compilation of data into new text files. This presentation provides a demonstration of its use in the development of ethnomedical data relevant to the utilization of medicinal plants in the treatment of diabetes among Native American groups.

Joseph C. WINTER, University of New Mexico, Albuquerque, NM
AN OVERVIEW OF PREHISTORIC AND HISTORIC TOBACCO DISTRIBUTION IN NORTH AMERICA

This paper summarized the archaeological and ethnographic data concerning the use of four species of tobacco in North America: *Nicotiana rustica, N. attenuata,*

N. trigonophylla, and *N. quadrivalvis.* The remains of all four have been found in archaeological contexts, with *N. rustica* recovered from sites in the East, Southeast, and Southwest; *N. attenuata* and *N. trigonophylla* in the Southwest; and *N. quadrivalvis* in the upper Midwest. Comparisons between the prehistoric and historic occurrences of tobacco are made, and questions are raised about the cultural and ecological role of tobacco among Native American societies.

Laurie S. ZIMMERMAN, Texas A&M University, College Station, TX

RECONSTRUCTION OF PLANT RESOURCES OF HUNTER-GATHERERS ALONG THE WESTERN MARGIN OF THE GULF COAST AND THE TAMAULIPAN BIOTIC PROVINCE

The floral resources utilized by Archaic and Late Prehistoric hunter-gatherers along the western margin of the Gulf Coast and the Tamaulipan biotic province are not well known because environmental conditions are not conducive for preservation of botanical remains. In spite of these difficulties, the integration of three key data sources provides a unique opportunity to reconstruct plant resources and potential plant resources of the area. These components include charcoal and seed remains recovered from archaeological sites, ethnohistoric accounts, and modern surveys of the vegetation. The present study reviews the data base formed by the integration of each of these components, and discusses the problems which must be considered.

J. Ethnobiol. 10(2):265–268 Winter 1990

NEWS and COMMENTS

CONGRATULATIONS

No less than three ethnobiologists have been honored this year by the John D. and Catherine T. MacArthur Foundation with prestigious MacArthur fellowships. These fellowships provide generous annual stipends for five years. Winners are:

GARY PAUL NABHAN, well known to Society members for his active participation in and support of our organization. Gary is assistant director for research and collections at the Desert Botanical Garden, Phoenix, Arizona. The fellowship will support his ongoing research and writing on indigenous agricultural systems and ethnobotany of the southwest.

KENT WHEATLEY, co-founder and co-director of the Seed Savers Exchange in Decorah, Iowa. The Exchange preserves heirloom varieties of crop plants in order to preserve the gene pool that has been greatly eroded by modern trends in agriculture. He has edited the *Garden Seed Inventory* (1988) and the *Fruit, Berry and Nut Inventory* (1989), mail-order nursery catalogs.

MARIA VARELA, head of *Rural Resources,* a New Mexico development organization that works in rural communities of the Southwest to maintain the agricultural and cultural heritages of hispanic and native American communities.

CONFERENCES

Society of Ethnobiology Fourteenth Annual Conference:

March 13–16, 1991, St. Louis, Missouri. For information contact: Ethnobiology Conference, c/o Patty Jo Watson, Department of Anthropology, Campus Box 1114, Washington University, One Brookings Drive, St. Louis, MO 63130.

International Symposium on Food and Nutrition in the Tropical Forest: Biocultural Interactions and Applications to Development

September 10–13, 1991, Paris, France (UNESCO and CNRS sponsored). For information contact: C.M. Hladik, Laboratoire d'Ecologie du MNHN, 4, Avenue du Petit Chateau, 91800 Brunoy, France.

Ethnobotany Computer Conference:

This service has been established on the San Diego State University VAX system NOTES conference to facilitate the interchange of information among those interested in ethnobotany, particularly ethnomedicine. The NOTES conference is accessible through mainframe systems which have TELNET capabilities. Accounts and instructions are available from: Michael Winkelman, Anthropology, Arizona State University, Tempe, AZ 85287–2402. Phone: (602) 965-6213. E-mail: ATMXW@ASUACAD.

PROCEEDINGS

The Goeldi Museum of Natural History announces publication in two volumes of the proceedings of the First International Congress of Ethnobiology (Belem,

BRAZIL, 1988) entitled *Ethnobiology: Implications and Applications*. These volumes include sections on "Ethnobiology in Theory and Practice," "Ethnozoology," "Botanical Resources," "Natural Resource Management," "Ethnopharmacology," and "Ethnomedicine and Popular Curing." The task of editing was shared by Darrell A. Posey, William Leslie Overal, Charles R. Clement, Mark J. Plotkin, Elaine Elisabetsky, Clarise Novaes da Mota, and Jose Flavio Pessoa de Barros. The two volume set was initially offered at $45 US (+ $28 US for airmail). You may order your set from the Museu Paraense Emilio Goeldi Editorial Department / Attention Dr. William Overal, P.O. Box 399, Belem, Para, BRAZIL.

REQUEST FOR HELP

Mr. Ronald J. Leeb of Tarzana, California writes to request information concerning the possibility that exposure to castor bean *(Ricinus communis* L.) may contribute to Amyotrophic Lateral Sclerosis (ALS, aka "Lou Gehrig's disease") and/or any potentially useful information on indigenous uses of castor bean. Mr. Leeb writes, "I have had ALS going on eleven years now. I'm 33 years old . . . I have just completed four years of anthropology at Pierce Community College and I'm headed for Cal State Northridge to continue [my] education . . . but my muscles are atrophying and wasting away slowly, but surerly . . . You can help me . . . by sending me a list of ethnobotanists, medical anthropologists who might be of help to me . . . What effect would small doses of the castor bean toxin [to which I was exposed as a child] have on the human body? Is there a test that would tell the level of exposure? . . . and, if so, is there an antidote? . . . Any ideas or help would be appreciated."

If you believe you might have some useful information to share with Mr. Leeb, please write or call him at 5332 Garden Grove, Tarzana, CA 91356, (818) 881-0361.

NEWS ITEM

Protection sought for old-growth Pacific yew trees *(Taxus brevifolia):* "The petition to Interior Secretary Manuel Lujan [for listing as "threatened"] could open a new front in the battle over logging in the old-growth forests of the Pacific Northwest, which so far has focused on protecting the northern spotted owl. The bark of Pacific yew has recently been targeted as a source of a rare cancer-fighting drug, taxol, which has been shown in recent clinical trials to be effective in a third of women whose ovarian cancers did not respond to conventional treatment. "The timber industry lashed out at the proposed listing. 'This is just another . . . addition to the 'species of the month' club,' said Kevin Brett, vice-president of the American Forest Resource Alliance . . . 'These special-interest groups have absoluely no shame,' he said. ' . . . they are utilizing the legitimate fight against ovarian cancer to mask their real objective . . . the locking up of millions of acres of forest land.'" The U.S. Forest Service opposed listing on the belief that the tree is "so abundant it needs no special protection."

—*Seattle Post-Intelligencer*
20 September 1990, pg. A-3

GRANTS

The Jacobs Research Funds invite applications for small grants (maximum $1200 US) for research in the field of social and cultural anthropology among living American native peoples. Preference will be given to the Pacific Northwest as an area of study, but other regions of North America will be considered. Field studies which address cultural expressive systems, such as music, language, dance, mythology, world view, plastic and graphic arts, intellectual life, and religion, including ones which propose comparative psychological analysis, are appropriate.

Funds will not be supplied for salaries, for ordinary living expenses, or for major items of equipment. Projects in archaeology, physical anthropology, applied anthropology, and applied linguistics are not eligible, nor is archival research supported.

For information and application forms, contact the Jacobs Research Funds (formerly the Melville and Elizabeth Jacobs Research Fund), Whatcom Museum of History & Art, 121 Prospect St., Bellingham, WA 98225, (206) 676-6981. Applications must be postmarked on or before February 15, 1991.

CIKARD NEWS

CIKARD is the "Center for Indigenous Knowledge for Agriculture and Rural Development" (318B Curtiss Hall, Iowa State University, Ames, IA 50011). Here are highlights from Volume 2, Number 2 of the *CIKARD News,* May 1990.

CIKARD is establishing a comprehensive documentation unit and library on relevant aspects of indigenous knowledge, according to Gerry McKiernan, editor, *CIKARD News,* to be housed at ISU.

In May 1990 the Leiden Ethnosystems and Development Programme (LEAD), Dr. L. Jan Slikkerveer, Chair, co-sponsored an international symposium on the "Origins and Development of Agriculture in East Africa: The Ethnosystems Approach to the Study of Early Food Production in Kenya" in cooperation with the National Museums of Kenya.

RAFI Communique, newsletter of the Rural Advancement Fund International, has recently aired discussions of "the importance of indigenous innovation and experimentation to crop improvement worldwide and the validity of claims by the South for appropriate compensation for its germ plasm" (RAFI, P.O. Box 1029, Pittsboro, North Carolina 27312; subscriptions $20 US).

Kleinhans Fellowship program has been established by the Rainforest Alliance to promote research on practical means of managing and utilizing tropical forest resources without destroying the integrity of the forest ecosystem. Fellowships provide $30,000 US for two years. For information contact the Rainforest Alliance, 270 Lafayette St., Suite 512, New York, New York 10012, (212) 941-1900.

CEICADAR (Centro de Ensenanza, Investigacion, y Capacitacion para el Desarrollo Agricola Regional), a center of the Graduate College of Montecillo, conducts rural appraisal studies in Mexico to identify and analyze traditional agricultural practices. For information contact Alfonso Macias, the Director of CEICADAR, Apartado Postal I-12, Col. La Libertad, Puebla, Puebla, Mexico, (5222) 49-39-45.

Interested in camels? Contact the Camel Research Unit, Prof. Babiker Musa, Dean, Faculty of Veterinary Science, University of Khartoum, P.O. Box 32, Khartoum North, the Sudan.

JOURNAL OF ETHNOBIOLOGY TO HAVE NEW EDITOR

Willard Van Asdall, who has edited the *Journal* since 1982, will be taking early retirement at the end of the current academic semester. The editorship will be assumed by Deborah M. Pearsall on or about June 1, 1991.

Effective immediately, all new manuscripts written in the English language should be submitted to: Deborah M. Pearsall, Editor, *Journal of Ethnobiology,* American Archaeology Division, 103 Swallow Hall, University of Missouri, Columbia, Missouri 65211 USA. Telephone: (314) 882-3038; FAX: (314) 882-9410; BITNET: ANTH DP at UMVMB.

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GUIDELINES FOR AUTHORS
GENERAL INFORMATION

The *Journal of Ethnobiology* invites manuscripts on original research in any area of ethnobiology including, but not limited to, ethnotaxonomy, ethnobotany, ethnozoology, cultural ecology, plant and animal domestication, zooarchaeology, archaeological botany, palynology, dendrochronology, and ethnomedicine. The *Journal* editorial staff encourages authors to use personal pronouns, the active voice, and verbs of power. We ask authors to construct dynamic topic sentences which connect a series of well–integated paragraphs. Since topic sentences should be supported by additional evidence or argument, please avoid one or two sentence paragraphs. In the material that follows, we give instructions and suggestions for manuscript preparation.

Typing the manuscript.—Manuscripts must be typewritten using a new ribbon, doubled spaced throughout (abstracts, text, literature cited, legends, and notes) with pica or elite type on 21.5 x 28 cm (8½ x 11 inches) paper with at least 2.5 cm (one inch) margins on all sides. Manuscripts generated on a computer printer should be printed on a laser, daisywheel, or near letter quality printer. Computer generated graphics are acceptable only if they are printed with a laser printer.

Illustrations.—The ratio of tables and figures to text pages should not exceed 1:2–3. All illustrations are considered figures and should be submitted reduced to a size which can be published within a *Journal* page without further reduction. Photographs should be black and white glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author's name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate sheet at the end of the manuscript.

Tables.—Tables should not duplicate material in either the text or graphs. Each table should be typed on a separate page and appended to the manuscript and must include a brief and self–explanatory title. The image area on a *Journal* page measures approximately 20 x 12.5 cm (5 x 8 inches). Take this into account in preparing tables. Fold–out tables ordinarily will not be accepted.

Scientific names and voucher specimens.—All generic and subgeneric names must be underlined and authors of species of plants and animals given the first time each is mentioned in the text. Avoid underlining for emphasis. Contributors to the *Journal* also should state where voucher specimens have been deposited for curation. The rationale for these requirements can be found in:

BYE, ROBERT A., JR. 1986. Voucher specimens in ethnobiological studies and publications. Journal of Ethnobiology 6:1–8.
REA, AMADEO M. 1986. Verification and reverification. Problems in archaeofaunal studies. Journal of Ethnobiology 6:9–18.
KUHNLEIN, HARRIET V. 1986. Food sample collection for nutrient analysis in ethnobiological studies. Journal of Ethnobiology 6:19–25.

Native language terminology.—If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemic inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with normal use of *italic type* for foreign terms and latin binomials. If necessary, the distinction between lexical glosses, i.e., English (or Spanish) language approximations of a term's referential meaning, and precise English (or Spanish) equivalents or definitions should be indicated by enclosing the gloss in a single quotation mark.

Miscellaneous.—Use metric units for all measurements; English units may be added in parentheses. Do not place footnotes at the bottom of the text pages; list these in order on a separate page at the end of the manuscript.

Submitting the manuscript.—Submit all English language manuscripts to the *Journal* Editor. All Spanish language manuscripts should be submitted to the Spanish language Associate Editor. Authors must submit two copies of their manuscripts plus the original copy and original figures. Copies of illustrations must be clear and suitable for review.

ORGANIZATION

Title page.—The title page is primarily for the convenience of the editorial staff. Center the title of the manuscript in capital letters. Lower on the page center the name and affiliation and address of the first named author, then of any co–authors. On the lower third of the page, give telephone numbers for at least the first named author. Below this, give information relating to any temporary addresses (e.g., summer address, field address). The title and names, affiliations and address(es) of the author(s) are to be repeated on the first page of the actual manuscript.

ABSTRACT.—With rare exceptions (e.g., a position paper) each manuscript must include an informative abstract which briefly summarizes the information presented in the text. The format for the abstract differs for the rest of the text in that the heading "abstract" is placed on a separate line flush with the left margin and is capitalized; the first paragraph of the abstract is not indented. The abstract in English is to be followed by one in Spanish (RESUMEN) and in French (RESUME). Examples can be found in this volume. (This entry in the "Guidelines for Authors" is correct format for the abstract.)

Headings.—Center First-Order Headings on a separate line, separated from the previous paragraph by two double spaces. Headings are written in capital letters. The heading "GENERAL INFORMATION" in this "Guidelines for Authors" is a first-order heading. Second-Order Headings are placed flush with the left margin, written in capital and lower case letters, underlined, followed by a period and a long dash and are separated by two doubles spaces from the preceding paragraph. The heading "Typing the manuscript" in this "Guidelines for Authors" is the correct format for a second-order heading. If Third-Order Headings are absolutely necessary, they are written in capital and lower case letters and indented as in a normal paragraph and followed by a period. Text immediately follows a third-order heading. There are examples of third-order headings in this "Guidelines for Authors" under "Citations," below. Do not use more than three orders of headings.

Citations.—Underline titles of books and journals that appear in the text of your manuscript. For example, "Schultes and Raffauf (1990) in their book *The Healing Forest: Medicinal and Toxic Plants of the Northwest Amazon* report that ..." This style is permitted occasionally for variety. Generally, titles of published works do not appear in the text. Follow the examples below to cite previously published articles, books, and materials.

Single reference. Gade (1985), or (Gade 1985).

Multiple references. Posey (1984, 1986), or (Posey 1984, 1986). Posey (1986) and Balee (1989), or (Posey 1986; Balee 1989); (Posey 1984, 1986; Balee 1989).

Multiple authors. Farrington and Urry (1985), or (Farrington and Urry 1985). For more than two authors: Klippel *et al.* (1987), or (Klippel *et al.* 1987).

Unpublished sources. The *Journal* editorial staff discourages the use of unpublished sources. It is difficult, often impossible, for the reader to verify or check the interpretation of material cited in this way. If it is absolutely necessary to use an unpublished source, please aid the reader by providing additional information as a note, e.g., the name and address of the person being quoted or paraphrased or the name and address of the person and/or institution where the information is on file or on deposit. Because of the detailed information to be placed in the "NOTES" section, unpublished sources do not appear in the "LITERATURE CITED" section. Follow these examples for citations.

Joe E. Doe (personal communication 1989)[1], or John E. Doe (written communication 1989)[1]. Also: Jane E. Doe (report in the files of ... 1989)[2], or Jane E. Doe (manuscript in the files of ... 1989)[2], or John E. Doe (data on specimen label ... 1959)[1].

Notes.—Footnotes are not permitted at the bottom of pages. Notes, if any, appear at the end of the manuscript, immediately before the Literature Cited section. This is the appropriate place for a current address of one or more of the author(s) to appear. Consult this volume for examples.

Acknowledgements.—Although acknowledgements are commonly given, they are optional. If you have such a section, place it at the end of the text of the manuscript, i.e., after "Notes" (if any) and before "Literature Cited." See examples in this volume.

LITERATURE CITED

Note, in the examples below, that authors of the works cited in the text of the manuscript are to be given here as they were in the original publication, i.e., with fully written names, with first names and an initial, or with initials only as in the original article. The works cited in the text of the manuscript are arranged alphabetically by author with the names of authors and co-authors in capital letters. Also note in these examples that neither titles of books nor of journals are underlined. Only the first word in the title of a book or a journal article is capitalized, except for proper nouns, place names, and names of persons. Write out the names of books and journals titles completely; do not abbreviate as the space saved in not worth the information lost. Do not list works which are not cited in the text of the manuscript. In addition to those given below, consult examples in this volume.

ADAMS, KAREN R. 1984. Evidence of wood-dwelling termites in archaeological sites in the southwestern United States. Journal of Ethnobiology 4:29–43.

ADAMS, KAREN ROGERS. 1988. The ethnobotany and phenology of plants in and adjacent to two riparian habitats in southeastern Arizona. Ph.D. dissertation. (Ecology and Evolutionary Biology), University of Arizona, Tucson.

ANDERSON, EDGAR. 1956. Man as a maker of new plants and new plant communities. Pp. 763–777 *in* Man's role in changing the face of the Earth (William L. Thomas, Jr., editor). University of Chicago Press, Chicago.

HARLAN, JACK R. and J.M.J. DEWET. 1965. Some thoughts about weeds. Economic Botany 19:16–24.

HASTORF, CHRISTINE A. and VIRGINIA S. POPPER (editors). 1989. Current paleoethnobotany, analytical methods and cultural interpretaton of archaeological plant remains. University of Chicago Press, Chicago.

SLEDGE, W. ARTHUR and RICHARD EVANS SCHULTES. 1988. Richard Spruce: A multi-talented botanist. Journal of Ethnobiology 8:7–12.

ABRIDGED MINUTES OF THE BOARD OF TRUSTEES MEETING OF THE SOCIETY OF ETHNOBIOLOGY TEMPE, ARIZONA 21 MARCH 1990

The meeting was called to order by President Elizabeth Wing at 9:00 a.m. in the Conference Room, Department of Anthropology, Arizona State University, Tempe. Board members present or attending later included Wing, Willard Van Asdall, Jan Timbrook, Robert Bye, Edelmira Linaris, Steve Emslie, Amadeo Rea, Paul Minnis, and Catherine Fowler. Gary Nabhan (1990 Conference Chair) and Julie Hansen also attended.

Discussion commenced with a proposal by Julie Hansen to host for next year's (1991) meeting at Boston University. It would perhaps be held in conjunction with a meeting of the Association for Environmental Archaeology, a European-based organization. After discussion of the financial complications of and lack of lead time for such a joint venture, Hansen withdrew her offer for 1991 in favor of a venue in 1992 or 1993. Other suggestions for 1991 entertained last year had included Washington, D.C. (Smithsonian Institution) and College Park, TX (Texas A & M). Neither of these offers fully materialized. In the absence of a firm committment, the choice of a site for 1991 was deferred. (The 1991 site was later settled as Washington University, St. Louis, with Patty Jo Watson as coordinator; see announcement, this issue.)

Secretary/Treasurer Cecil Brown's financial report and accompanying letter were read by President Wing and discussed by the board. In light of the financial situation, it was decided that a dues raise for 1992 was regretably required. Rates were set at $35 for individuals, $60 for institutions, and $25 for Latin American members and for students. Other membership categories proposed and adopted were: life member—$1,000, payable in one payment or at the rate of $200/year over 6 years, or $250/year over 5 years; supporting member—$100/year; Society Benefactor—$5,000.

The Society's outstanding debt of $7,000 (start-up money) was discussed and a commitment made to begin to retire it with $5.00 of each member's dues going toward this purpose, beginning in 1992. Some monies will be committed in 1991 as well, to begin this process. Other proposals for exploring revenue generating activities were suggested by Emslie and Wing. Both will follow up on these ideas and communicate to the Board at a later time. Minnis was to report to the Journal Editorial Board on proposals to accept limited advertising in each issue of the *Journal* for this purpose.

Elections this year (1991) are needed to replace Trustee Bye and President Elect Minnis. Emslie and Rea agreed to serve on the nominating committee. Ballots will be distributed before March 1, 1992.

The remainder of the discussion centered around issues facing publication of the *Journal,* such as the problem of intellectual property rights, other legal parameters, and the possibility of instituting pages charges. This discussion was continued to the afternoon Editorial Board session (see minutes, last issue). The meeting was adjourned at 12:00 p.m.

NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting resent issues of the *Journal.* If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

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NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to one of the *Journal's* book review editors. Please see inside front cover for names and addresses.

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Journal of Ethnobiology

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VOLUME 11, NUMBER 1 SUMMER 1991

Three-Men-In-A-Boat

One of my house plants is in full and glorious flower now. *Exotica,* the marvelous book on house plants refers to it as *Rhoeo discolor,* seed catalogues list it as Moses–In–A–Boat, but my mother called it Three–Men–In–A–Boat. Call it what you like or call it nothing at all, it is a handsome, old–fashioned house plant with large, strap–shaped leaves which are glossy–green above and a rich purple below. Several (usually more than three) small, white flowers develop within boat–shaped bracts, hence the common names. Belonging to the pine-apple family, these plants will survive (but not with vigor) fairly long periods of abuse and neglect, recovering quickly after, for example, you have returned from your vacation and resume your T.L.C. (tender, loving care).

I have several Three–Men–In–A–Boat plants. They are cuttings of cuttings of cuttings given to me by my mother almost 30 years ago. She had received a plant of *Rhoeo discolor* in the 1940s as a birthday gift from her aunt Angie, who had bought a plant many years before that from a commercial source. In their turn, cuttings of my plants have gone to Indiana to grace the homes of my siblings there and to homes of friends and relatives in several cities and towns across the land.

I know the "genealogy" of most of my house plants—for example my Pedalanthus (Devil's Back Bone), Chinese Evergreen, and Joseph's Coat of Many Colors—just as my parents and their neighbors, friends and relatives knew which varieties of their Tiger Lilies, Day Lilies, Peonies, Irises, Tulips, Raspberries, Strawberries, Rhubarb, Quince, Apple and Pear trees, etc., had come to them through purchase, gifts, or exchange.

Following the example set by Vorsila Bohrer, I had a section in my Ethno-botany course called "Plants in the Company of Man." Although the emphasis was on the evolutionary changes of plants in the company of man, surely the close relationship one can have with individual plants in and around one's dwelling is one—albeit very small, very personal, and very satisfying—aspect of ethnobotany.

—W.V.

FIFTEENTH ANNUAL ETHNOBIOLOGY CONFERENCE

25–28 MARCH 1992

SMITHSONIAN INSTITUTION
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Contact:

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Department of Anthropology
National Museum of Natural History
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Washington, D.C. 20560, U.S.A.

THE STATEMENT OF DELEGATES OF THE SECOND INTERNATIONAL CONGRESS OF ETHNOBIOLOGY

OCTOBER, 1990

KNOWN AS "THE KUNMING ACTION PLAN — KAP"

During the Second International Congress of Ethnobiology, held in October, 1990, an action plan called KAP (The Kunming Action Plan) was established to implement general principles set forth in "The Declaration of Belém" by delegates of the First International Congress of Ethnobiology held in Belém, Brazil, in 1988, (see *Journal of Ethnobilogy* 8(1):iii–v, Summer 1988).

KAP calls for specific actions designed to secure protection of Intellectual Property Rights (IPR) for native peoples (see *Journal of Ethnobiology* 10(1):93–98, Summer 1990). Furthermore, an extensive educational program was envisioned, including permanent training centers to teach the basic skills necessary to develop a new synthesis of scientific disciplines, including ecology, anthropology, linguistics, geography, regional planning, biology, and economics, and the extensive use of the media. Educational materials on traditional knowledge and alternative systems of natural resource conservation will be prepared for many parts of the world.

KAP established a *Global Coalition for Biological and Cultural Diversity* to facilitate cooperation between indigenous peoples, environmentalists and scientists in the preservation of the natural and human heritage of the Planet. A major goal of the *Global Coalition* is to establish mechanisms for the exchange of ideas and experiences between indigenous and native peoples, scientists, and environmentalists.

Given that the "Declaration of Belém" from the 1988 First International Congress of Ethnobiology called for specific action to aid native peoples and to stop the needless destruction of the precious natural resources of this planet upon which all peoples depend;

THEN BE IT RESOLVED THAT:

A *Global Coalition for the Defense of Biological and Cultural Diversity* be herewith established to encourage the permanent and meaningful dialogue between indigenous peoples, scientists and environmentalists in order to develop a unified strategy to defend the biological and cultural diversity of planet Earth.

Membership of the *Global Coalition* will consist of those individuals and institutions who wish to work in unity guided by the following principles:

1. Members will actively seek organizations to join the Coalition;
2. Members will collaborate with indigenous organizations and indigenous peoples to develop multi–cultural, multi–lingual education and training materials; Members will actively request governments and educators to use these materials;
3. Member researchers will take an ethically and socially responsible approach in their dealings with indigenous/native peoples and will provide a full feedback of their findings and results;

4. Members will use and engage the media whenever, wherever, and however possible to promote ''The Declaration of Belém'' and the ''Kunming Action Plan;''

5. The *Global Coalition* demands to be heard in the United National Conference on Environment and Development (UNCED) and will actively pursue representation;

6. Members will work to guarantee that indigenous knowledge be duly considered in national and international development programs and projects;

7. Members will help to secure the recognition of traditional and indigenous knowledge as inventive and intellectual, and, therefore, worthy of protection in all legal, ethical, and professional frameworks;

8. Members will form an Ethics Committee to set standards and monitor the progress of the Kunming Action Plan;

9. Members will establish a ''Strategy for the Global Coalition'' to guide activities for 1992 and beyond.

A GENERAL STRATEGY FOR THE *GLOBAL COALITION FOR BIOLOGICAL AND CULTURAL DIVERSITY*

The *Global Coalition* immediately set out to establish a General Strategy to make the voices of local peoples heard and the importance of traditional knowledge in the conservation of biodiversity be known.

The General Strategy begins with preparations for the 1992 United Nations Conference on Environment and Development (UNCED) as its highest priority. Since 1992 also marks the 500th anniversary of the ''discoveries'' of the Americas, both events will be linked in the General Strategy, which is focused upon pre- and post-UNCED events rather than directly upon the ECOFORUM. The General Strategy is designed to complement the efforts of ECOFORUM, thereby filling voids rather than competing for the already very cramped time slots during UNCED.

The following activities/events are programmed:

1. March, 1991. International planning meeting in Vancouver (Canada) with KAP directors and the World Council of Indigenous Peoples.

2. April, 1991. European planning meeting to outline objectives and priorities (tentatively scheduled for Munich or London).

3. June, 1991. A special conference in California will be held to prepare the Briefing Documents to be used for future activities (press and displomatic briefings, as well as for the WorkShows). These documents must be concise and clear, and summarize the relationships between local communities/native peoples and their control over their own natural resource base in relation to conservation of biodiversity. Summaries must also be made to show the historic and modern relationships of native peoples to their environments (as molders, conservers, and defenders of their lands and resources), including specific case studies. Clear statements of desired actions and policies necessary to include traditional knowledge and native peoples in

the forefront of new conservation, biodiversity, and forestry conventions, protocols, etc. will be included.

4. Throughout 1991. Press and Diplomatic briefings to inform, educate, and alert the press to the human issues of conservation and development that must be included in the UNCED. These will be held in Geneva, Brussels, New York, and other major world capitals. Some briefings will be held *in situ,* i.e., in the rainforest with native peoples.

5. February, 1992. WorkShow International. "WORKSHOW" (not 'SHOP') is planned to unite world famous artists with indigenous and scientific leaders. The goal is to call world attention to what native peoples have to say utilizing the artist world (singers, actors, theatre and television stars, etc.) as their mouthpieces.

   The encounters will take place on indigenous reserves in various parts of the world and will be filmed to produce a documentary for television. Six sites (Australia, Brazil, Canada, Mexico, Panama, India, Camaroon) have been tentatively selected. Tentatively this documentary will be shown during the UNCED meetings and the manifestations of indigenous peoples there. Perhaps a live show can also be arranged. It is hoped that this WORK-SHOW will be televised worldwide. One possibility is that there would be simultaneous shows in North America, Europe and Brazil. This will be discussed at a New York planning meeting in March, 1991.

6. Pre-UNCED Mini-Courses. The two months before the 1992 meetings will be used to organize a series of Mini-Courses for the international press. These will deal with various aspects of cultural and biological diversity. Mini-courses on indigenous agriculture, folk medicine, alternative foods, ethnoastronomy, marketing and "natural products," indigenous environmental education, etc. will be offered by the leading world experts on these subjects, together with indigenous shamans and specialists. [Note: if the ISE Congress is scheduled for April or later, some of the Mini-courses and briefings could take place in Mexico.]

7. April or October, 1992. Another major event of 1992 will coincide with the Third International Congress of Ethnobiology and the World Council of Indigenous Peoples. [One proposal would dovetail the ISE and WCIP Congresses so that delegates from both could come together for a major gathering.] The "manifestation" will be held on the site of the Indian ruins of Mexico City. The theme of the meeting will be "500 Years of Lost Knowledge?" and will focus on the ignorance of European cultures in having lost so much knowledge about how to use the biological and ecological diversity of the Americas [but emphasizing that all is not lost yet, if major changes are undertaken to preserve the remaining indigenous/native peoples of the Earth, and, needless to say, the natural resources upon which they/we depend.] The Mexican ISE organizers want to have at least 4,000 Indians from all over the Americas present for the event.

It is very important that 1992 not be the *goal* of our efforts, but rather the stepping-stone to a forceful and effective dialogue between scientists, environmentalists, and native peoples for all of the decade—and beyond! As you well

know, there is no time to waste. We must put together all of the pieces now, and a 1992 goal is the kind of effective deadline that is useful. After 1992, the *Global Coalition* hopes to capitalize upon the networks formed during 1992 in order to have a more permanent and effecive voice in international political, economic, and scientific centers. In this way, the ideas and wishes of native and local peoples can become increasingly heard by those seeking alternative models for effective conservation of cultural and biological diversity of the planet.

J. Ethnobiol. 11(1):1–22 Summer 1991

ANIMALS IN THE NAMBIQUARA DIET: METHODS OF COLLECTION AND PROCESSING

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ABSTRACT.—This study reports items of animal origin observed to be consumed in two Nambiquara Indian villages and describes how these foods were obtained and processed. The Alantesu village (A) is located in the forest of the Guaporé Valley and Juina (J), in the cerrado (savanna) of the Chapada dos Parecis, both in the state of Mato Grosso, western Brazil. Although similar methods were used to obtain and process animal items, the two villages presented clear differences in the taxonomic composition of these items (A, more fishes; J, more insects and birds, for example) and the total number of species (A: 69 spp. vs. J: 90 spp.) observed in the diet. Qualitative and quantitative differences in the fauna in the neighborhood of each village largely explain the dietary differences. The methods by which items were obtained and processed by the two populations did not differ much, not only because they shared the basic southern Nambiquara culture, but also because the behaviors of the major food species are similar. The cerrado group possessed special techniques for gathering grasshopper nymphs and winged termites whereas the forest group used a wider variety of fishing techniques; each technology is associated with the greater availability of the animals being targeted.

RESUMO.—Este estudo relata os itens de origem animal cujo consumo foi observado em duas aldeias indígenas Nambiquara durante períodos padronizados de observação e descreve como estes alimentos foram obtidos e processados. A aldeia Alantesu (A) localiza-se na floresta do Vale do Guaporé e a Juina (J), no cerrado da Chapada dos Parecis, ambas no estado do Mato Grosso, Brasil. Embora os índios usem métodos semelhantes na obtenção e no processamento dos itens animais, as duas aldeias apresentaram diferenças claras na composição taxonomica destes itens (A, mais peixes; J, mais insetos e aves, por exemplo) e no número total de espécies (A: 69 spp. vs. J: 90 spp.) observadas na dieta. Diferenças qualitativas e quantitativas na fauna dos arredores de cada aldeia explicam amplamente as diferenças na dieta. Os métodos usados na obtenção e no processamento dos itens pelas duas populações não diferem muito, não só porque eles compartilham a cultura Nambiquara do Sul básica, como também porque os comportamentos das espécies principais de alimentação são semelhantes. O grupo do cerrado apresentou técnicas especiais para coleta de ninfas de gafanhotos e cupins alados enquanto o grupo da floresta usou uma maior variedade de técnicas de pesca; cada tecnologia está associada com a maior disponibilidade dos animais alvo.

RÉSUMÉ.—Cette étude relate les éléments d'origine animale mangés par les Indiens Nambiquara de deux villages pendant des periodes d'observation standardisées et décrit comment ces aliments ont été obtenus et préparés. Le village Alantesu (A) se trouve dans la forêt de la vallée du Guaporé et la village Juina (J) dans le cerrado (savanne) de la Chapada dos Parecis, tous deux dans l'État de Mato Grosso, Brésil. Quoique des méthodes similaires aient été employées pour obtenir et préparer ces aliments, les deux villages ont présentés des différences nettes dans leur composition taxonomique (A, plus de poissons; J, plus d'insectes et d'oiseaux, par exemple) et dans le nombre total d'espéces consommées (A: 69 spp. vs. J: 90 spp.). Les différences qualitatives et quantitatives de la faune aux environs de chaque village expliquent largement ces variations alimentaires. Les méthodes employées par les deux populations pour obtenir et preparer ces éléments ne différent guére, non seulement parte que elles partagent la culture de base Nambiquara du Sud, mais aussi parce que les comportements des espéces principales de l'alimentation sont similaires. Le groupe du cerrado a presénté des téchniques spéciales pour la récolte des nymphes de sauterelles et des termites ailés, tandis que le groupe de la forêt a utilisé une plus grande variété de téchniques de pêche; chaque téchnologie correspond á la plus grande disponibilité des animaux recherchés.

INTRODUCTION

American Indians in the course of 13,000 years or more of living in America (Guidon and Delibrias 1986), have developed an intimate knowledge of their environments and their natural products. The number of products used by Amerindian groups is known to be extensive but taxonomic data remain scanty. Detailed description of wild food resources and their indigenous utilization are rare for Brazil. Recent studies (e.g., Patton *et al.* 1982, Berlin & Berlin 1983; Posey 1983a, b; Prance & Kallunki 1984) have begun to compile and interpret these kind of data. Information on animal resources is critical to the interpretation of cultural awareness of the biological environment (Patton *et al.* 1982), efficiency of exploitation of energy and nutrient sources ("optimal foraging," Hames and Vickers 1982; Setz 1989) and questions concerning nutrient limitation on population size (Meggers 1954; Gross 1975). The present study focuses on two Nambiquara Indian villages, one in tropical forest and the other in savanna, and records dietary items of animal origin and describes how they are obtained and processed.

The Nambiquara Indians are a small, differentiated linguistic unit, consisting of three languages (Price and Cook 1969), restricted to the southwestern portion of the State of Mato Grosso and southern portion of Rondônia, Brazil (Fig. 1). Villages are distributed across upland habitat in a region of vegetation ranging from natural fields and savanna in the Chapada dos Parecis to tropical seasonal forest in Guaporé Valley. In the Guaporé Valley forest, contact betweeen the Nambiquara and non–Indians first occured in the first half of the 18th century with slaves fleeing from gold mining areas in the mountains around Vila Bela da Santíssima Trindade. In the cerrado areas of the Chapada dos Parecis, contact was established in 1907 with Marechal Rondon's expedition (Rondon 1947). In 1960, the construction of BR–364 highway opened the Guaporé Valley to ranching

and agroindustry. In the 1980s a new roadbed built through the Valley (see Fig. 1) intensified outside contact with the Nambiquara Indians in the area. The Nambiquara linguistics and geopolitical organization were studied by Price (1987, 1978). The ethnography of the Nambiquara agriculture is reviewed by Aspelin (1979a),

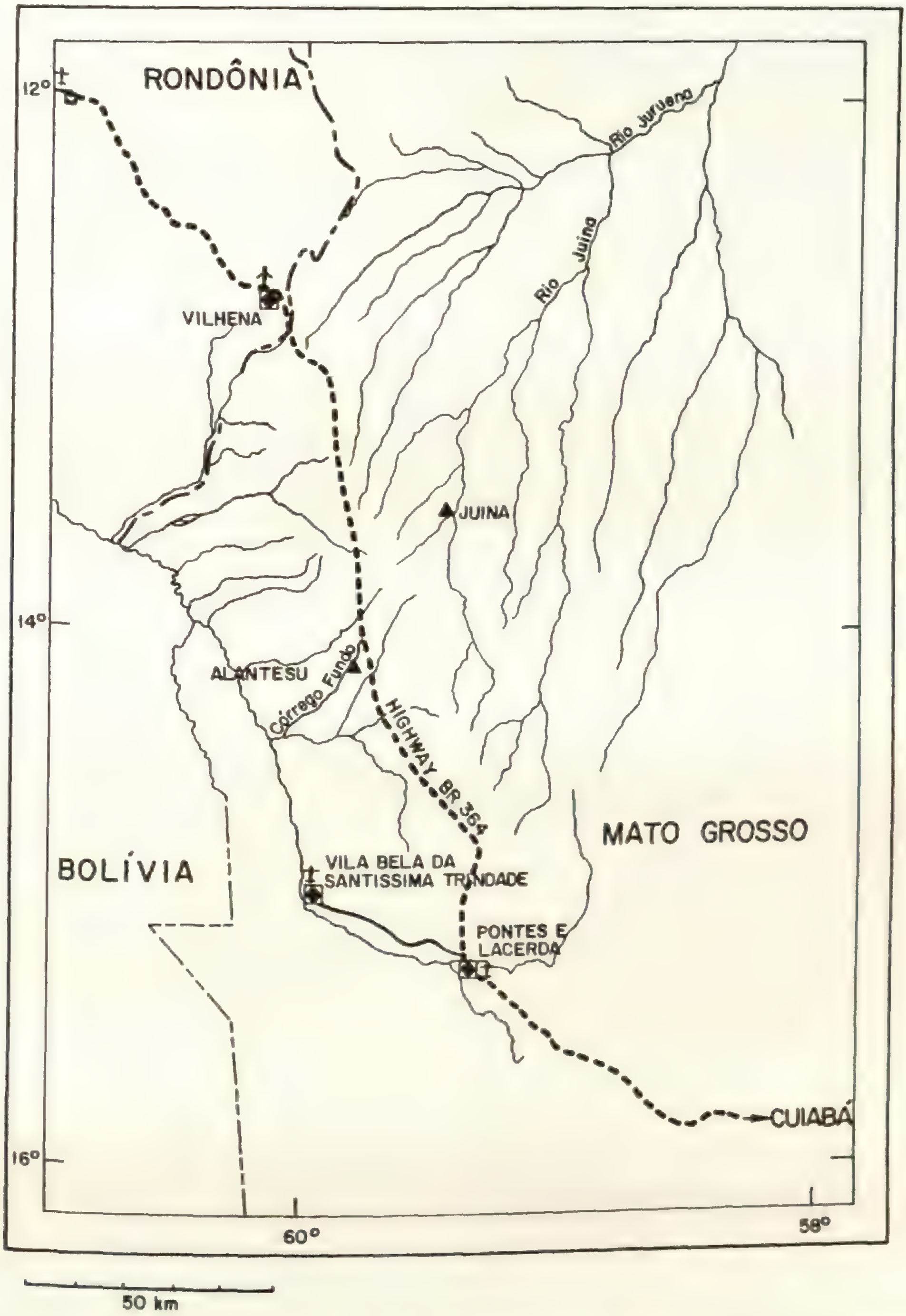

FIG. 1.—Map showing location of the Nambiquara villages (Alantesu and Juina) where the study was undertaken. The BR-364 highway had not been constructed at the time of the study.

which studied the food distribution and social bonding of the Mamaindê Nambiquara (Aspelin 1979b).

Differences in topography and elevation result in small variations in the warm and humid climate over the region (Nimer 1977). About 70% of the rainfall occurs from November to March (rainy season). Information on geology and vegetation of the Guaporé Valley and Chapada dos Parecis is found in Hoehne (1923, 1951) and in RADAMBRASIL Project (Brasil 1979).

Reports treating the Guaporé fauna are very scarce. Johann Natterer collected animals, seeds and minerals along the Guaporé River in 1829-1830; birds were studied by Pelzeln (1871) and Streseman (1951) and mammals by Pelzeln (1883). Information on the fauna of the Chapada dos Parecis is found in Miranda-Ribeiro (1914) and Roosevelt (1924). During Roosevelt's 1908 expedition, George Cherrie and Leo Miller collected vertebrates, among which were discovered many new species. Naumburg (1930) treated the birds collected by Cherrie together with other birds from Mato Grosso. Information on mammals collected by Miller is given by Allen (1916). Miranda-Ribeiro (1914) also gives an account of the mammals of the Chapada dos Parecis.

METHODS

Two Nambiquara villages 50 km apart were selected for study. The Alantesu village is situated on the "Córrego Fundo", a forest creek in Guaporé Valley, (14° 10'S, 59° 50'W). The other, Juina, is next to the Juina River in the cerrado (edaphic savanna) of the Chapada dos Parecis (13° 40'S, 59° 25'W). The two villages had similar number of inhabitants (in the range of 30 to 40 individuals) such that the total food demand of each group under observation was approximately equal. Villages of similar sizes were chosen to facilitate comparisons between groups in similar cultural and demographic settings in contrasting environments.

All dietary items of animal origin obtained by villages as well as the techniques used in their capture and preparation for eating were recorded during visits totaling approximately 10 months with the Alantesu and the Juina in 1978 (preliminary visit), 1979 (dry season) and 1981 (wet season). A total of 74 data collecting days (Oct, Aug-Sept, Dec-Jan) were spent with the Alantesu and 74 days (Nov, Sept-Oct, Jan-Mar) with the Juina.

Insect specimens were preserved in 70% alcohol: adult specimens were later mounted on pins. Whenever possible, freshly killed vertebrates were photographed and measured (total length of the specimen). Feathers of birds were collected and portions of the skin of reptiles were dried. Heads or whole fish specimens were preserved in 10% formalin. Mammals were measured (head and body length, tail length, external ear length and internal ear length) and the sex was noted. Skulls of primates and rodents were cleaned and dried. Skulls of small vertebrates were often broken during roasting, making identification impossible. The antlers of deer were preserved. When it was possible to obtain the skin of an animal, it was scraped, treated with borax and dried. Skins were tanned for permanent storage upon returning from the field. Collections were identified with

the help of experts.[1] Vouchers were deposited at the Museu de Zoologia of the Universidade de São Paulo, São Paulo (Coleoptera) and Museu de História Natural, Universidade Estadual de Campinas, Campinas, São Paulo (other insects and the vertebrates).

The Nambiquara names for many items were recorded as part of an effort to learn the Nambiquara language. The transcriptions follow Kroeker (1980).

RESULTS AND DISCUSSION

Dietary Items of Animal Origin.—In the Alantesu, ten species of bees were observed to provide honey, larvae and pupae and in the Juina eleven, giving a total of 18 bee species eaten and providing honey (Table 1). The abundance and diversity of bees furnishing honey in the Chapada dos Parecis was noted by Roquette* Pinto in 1912 (1975) and Lévi–Strauss in 1938/39 (1979).

Unspecified insects have been previously mentioned as components of the Nambiquara diet (Véllard 1941). Roquette-Pinto (1975) observed Brassolinae caterpillars being consumed. Beetle grubs (''corós'') and grasshoppers (''tucuras'') are cited repeatedly. Hoehne (1951) and Roquette-Pinto (1975) call attention to the abundance of grasshoppers in the Chapada. Grasshoppers were not observed to be eaten in the Alantesu village and are probably rarer in the forest. Hoehne (1951) comments that the forests that surround the Chapada restrict the distribution of the grasshoppers. Insects, mainly grasshoppers and grubs, are consumed more by the Juina during the rainy season; this is probably related to the seasonality of these insects. Lévi–Strauss (1948) observed the Nambiquara's eating of spiders.

Insects appear commonly in the diets of native groups from the Americas [Shoshone (Steward 1938 *apud* Dyson Hudson & Smith 1978), Yukpa (Ruddle 1973), Yanomam (Chagnon 1968)], Africa [Tongwe (Kakeya 1976)] and from Oceania [Tsembaga (Rappaport 1971)]. Coimbra (1984) reviews the use of Coleoptera larvae by Brazilian Indians.

Of 17 fish species recorded (Table 1) 16 were eaten by the Alantesu and eight by the Juina. The Nambiquara literature does not specify types of fish consumed. The difference in number of fish species consumed may be explained ultimately by differences in the ecology of the two drainage basins. The Juina, like the Tapajós of which it is a tributary (Sioli 1967 *apud* Goulding 1979), is a clear water river, almost free of sediments and seems poor in nutrients necessary for the development of extensive aquatic macrophytic communities (Goulding 1980). In contrast, the ''Córrego Fundo'' Creek is turbid, has a considerable sediment load and has abundant vegetation along its margins where the fishes are found and collected. In the Juina River, in addition to its apparently low productivity, the transparency of the waters makes fishing difficult (Véllard 1965 *apud* Aspelin 1979). All fish caught were eaten except for one ray (*Potamotrygon* sp.) with young at the Alantesu village. Its sting, however, was preserved by the Indians.

Lizards and snakes are mentioned as food items in the literature without indication of genus or species (Pyreneus de Souza 1920; Lévi-Strauss 1948). There is one reference to an iguana (Price 1981a), one to a coral-snake (Pyreneus de

TABLE 1.—*Animal items used in the diet by the Alantesu village, in the forest (F), and the Juina village, in the cerrado (C), on the visits: previous (p), dry season (d) and rainy season (r).*

Scientific name Order	Family	Species	Nambiquara name	Place/season	Stage or part used
INSECTS					
Orthoptera	Romaleidae	*Titanacris albipes*	—	Cr	adults
		Tropidacris collaris	Kwãdsu	Cr	adults
		Lophacris sp.	—	Cd Cr	
	Acrididae	*Rhammatocerus* sp.	Tukururatakkisu, Takkatasu	Cd Cr	nymphs
		Schistocerca sp.	Katinketatakisu, Katinkatatakisu	Cr	adults
Isoptera	Termitidae	*Syntermes* pr. *spinosus*	Kairu	Cr	soldiers
		(not collected)	Sauãnkisu	Cp	alates
Hemiptera	Indet.	(not collected)	Haieru	Cd	nymphs
Lepidoptera	Nymphalidae	*Brassolis sophorae*	Yaitenauhsu	Fd	
	Sphingidae	undet. 1	Alanauhsu	Cr	
		undet. 2	Waisenauhsu	Cr	
		undet. 3	Unrenauhsu	Cr	larvae
	undet.	undet.	—	Fd	
		undet.	Kluraitenauhsu	Cr	
Coleoptera	Cerambycidae	undet. 1	Wakehautenauhsu	FR	larvae
		(not collected)	—	Cr	adults
	Curculionidae	*Rhinostomus barbirostris*	Anauhtsu (larva), Hakalãinsu (adult)	Cr	
Hymenoptera	Formicidae	*Atta laevigata*	Sawendsu, Sawendu	Cp Cr	
		Atta sexdens sexdens	Sauãikisu	Fr	soldiers
	Vespidae	*Polybia (cylindroeca) dimidiata*	—	Fr	
		Polybia occidentalis complex	—	Cd	

	Pseudopolybia vespiceps	Ainanedundesu				Cr	larvae
	Apoica (apoica) pallens	Weweretasu, Wewehru			Cd	Cr	pupae
	Epipona quadrituberculata	—		Fr			
	(not collected)	Yanahtasu	Fd				
	(not collected)	—	Fd				
Apidae	*Trigona branneri*	Walatsu	Fd		Cd		
	Trigona hypogea	Waruatusu, Waraasu	Fd		Cd		
	Trigona dallatorreana	Ahatasu				Cr	
	Trigona (pisania) cilipes pellucida	Kaliãhatasu				Cr	
	Geotrigona leucogastra cf. *chiriquiensis*	—	Fd				
	Scaptotrigona nigrohirta	Jinotasu, Yusu	Fd				honey
	Scaptotrigona polysticta	—		Fr			stocked
	Scaptotrigona xanthotricha	—		Fr			pollen
	Cephalotrigona femorata	—			Cd	Cr	larvae
	Oxytrigona obscura	—	Fd	Fr			pupae
	Oxytrigona t. tataira	Tehaneisu (Tehaneneisu ?)			Cd		
	Melipona interrupta grandis	Senehantesu	Fd				
	Partamona ? cupira (new sp. ?)	—		Fr			
	Duckeola ghilianii	Wanesidisu				Cr	
	Tetragona quadragula	—			Cd		
	Tetragonisca angustula angustula	Waisu (?)			Cp Cd	Cr	
	Lestrimellita limao	Yacadensu, Ariausu (?)			Cd	Cr	
	Apis mellifera	?? Sanehante kwiritesu	Fd	Fr		Cr	

TABLE 1.—*Animal items used in the diet by the Alantesu village, in the forest (F), and the Juina village, in the cerrado (C), on the visits: previous (p), dry season (d) and rainy season (r).* (continued)

Scientific name Order	Family	Species	Nambiquara name	Place/season	Stage or part used
FISHES					
Characiformes	Characidae	*Astyanax bimaculatus*	Ayekalosu	Fd Fr Cr	meat
		(not collected)	Kain Herisu	Cr	
		Serrasalmus sp.	—	Fr	
	Erythrinidae	*Hoplias malabaricus*	Haiuru (C.)	Fp Fd Fr Cd Cr	
		Hoplias sp.	Ainatsu	Cp Cd Cr	
		Hoplerythrinus unitaeniatus	—	Fd	
		Erythrinus erythrinus	—	Fd	
	Anostomidae	*Leporinus* sp. (*maculatus* group)	—	Cd	
Gymnotiformes	Electrophoridae	*Electrophorus electricus*	Amkurisu	Fr	
Siluriformes	Pimelodidae	*Rhamdia* cf. *quelen*	Nenduhsu (?), Waiutsu	Fd Fr	
	Callichthyidae	*Callichthys callichthys*	—	Fd	
		Hoplosternum thoracatum	—	Fd	
	Loricariidae	*Pterygoplichthys* sp.	—	Fd Fr	
Perciformes	Cichlidae	*Crenicichla lepidota* (?)	Unkalisu	Fd Fr	
		Aequidens sp.	—	Fd Fr Cd	
undet.	undet.	(not collected)	—	Fr	
	undet.	(not collected)	Kouritsxu	Fr	
	undet.	(not collected)	—	Cr	
	undet.	(not collected)	Kananguesu	Cr	

AMPHIBIANS											
Anura	Bufonidae	*Bufo* sp.	Wxisu				Cp			meat
	undet.	(not collected)	—					Cd			
	Leptodactylidae	*Leptodactylus labyrinthicus*	—						Cr		
REPTILES											
Testudines	Testudinidae	*Geochelone* sp. *(denticulata* or *carbonaria)*	Yutaunsu, Yataunru, Yutaunru	Fp	Fd	Fr					
	undet.	*Podocnemis* sp.	—			Fr					
		(not collected)	—			Fr					
Sauria	Iguanidae	*Hoplocercus spinosus*	Yanuhsu, (Yanunsu ?)					Cd	Cr		
	Teiidae	*Tupinambis teguixin*	Nutatu (F)	Fp	Fd			Cd			
		Tupinambis rufescens (?)	Yawaru ?					Cd	Cr		
		Cnemidophorus lemniscatus (?)	Yanasu (F), Kadihsu (C)	Fp	Fd		Cp	Cd	Cr		
		(not collected)	—					Cd			
Serpentes	Boidae	*Boa constrictor* (?)	Disxu					Cd			
BIRDS											
Rheiformes	Rheidae	*Rhea americana*	Auhlu					Cd		meat	
Tinamiformes	Tinamidae	*Tinamus tao*	Hohsu	Fp	Fd	Fr		Cd			
Falconiformes	Accipitridae	*Accipiter bicolor*	Dantesu	Fp							
		undet. 1	Tkatkasu					Cd			
		undet. 2	Halunwairu (?)				Cp	Cd			
Galliformes	Cracidae	*Mitu mitu*	Alasu	Fp							
		Penelope cf. *jacquacu*			Fd			Cd			
Gruiformes	Cariamidae	*Cariama cristata*	Wanunktasu (F) Kwalxatsu (C)					Cd			
Columbiformes	Columbidae	undet.	Kwasxasu					Cd			

TABLE 1.—*Animal items used in the diet by the Alantesu village, in the forest (F), and the Juina village, in the cerrado (C), on the visits: previous (p), dry season (d) and rainy season (r).* (continued)

Scientific name Order	Family	Species	Nambiquara name	Place/season	Stage or part used
Psittaciformes	Psittacidae	*Ara ararauna*	Aratsu	Fd Cp Cd Cr	meat
		Ara chloroptera	—	Fd Fr	eggs
		undet.	—	Cr	
		Amazona sp. 1	—	Fr	
		Amazona sp. 2	Tatlaketsu	Fd	
		Amazona sp. 3	Ãuchru, Ãhuhru	Cd	
Strigiformes	Strigidae	undet. 1	Waiededensu, Waiedisu	Cd	
		undet. 2	Yetisu	Cd	
		undet. 3	—	Fp	
Caprimulgiformes	Nyctibiidae	*Nyctibius* sp. (prob. *griseus*)	—	Cd	
Piciformes	Bucconidae	undet.	Suhlu, Tucaluhlu, Tucaruru	Cd	
	Ramphastidae	*Ramphastos tucanus*	—	Fd	
		Ramphastos sp. 2	—	Cp	
	Picidae (?)	undet.	Jujutta (Jujuttsu)	Cd	
Passeriformes	Hirundinidae	undet.	—	Cd	
	undet.	(not collected)	Tanenetsu	Cr	
	undet.	(not collected)	—	Fr	
MAMMALS					
Marsupialia	Didelphidae	*Didelphis albiventris*	Yawala (su), Yawaru	Cd Cr	meat
Chiroptera	Phyllostomidae	*Desmodus rotundus*	Kaluhtesu	Fd	
		Glossophaga soricina	Kaluhsata (su)	Cd	
		Tonatia silvicola	—	Cr	

Primates	Cebidae	*Cebus* sp. (*apella* and/or *capucinus*	Hotsu	Fp	Fd	Fr				meat
		Pithecia irrorata	Kaulisu		Fd					
		Alouatta seniculus	Elhu	Fp		Fr				
		Alouatta caraya	Ilhu					Cd		
		Alouatta sp. (*caraya* or *belzebul*)	—			Fr				
		Ateles paniscus	Hotasu	Fp		Fr				
	Callithricidae	*Callithrix argentata*	Takisu						Cr	
Edentata	Myrmecophagidae	*Myrmecophaga tridactyla*	Tikakisu					Cd	Cr	
		Tamandua tetradactyla	Wãisu, Wãisxu (C)			Fr				
	Bradypodidae	*Choloepus hoffmanni*	Alaitsu	Fp						
	Dasypodidae	*Dasypus septemcinctus*	Nundsu (Ninsxu)				Cp		Cr	
		Dasypus novemcinctus	Ahratasu, Aarlu		Fd	Fr			Cr	
		Euphractus sexcinctus	Sanãisu				Cp	Cd	Cr	
		Priodontes maximus	Waruru	Fp			Cp	Cd	Cr	
		Cabassous tatouay (?)	Ahlutsu					Cd		
Rodentia	Echimyidae (?)	(*Ctenomys* sp. ?)	—						Cr	
	undet.	(not collected)	Alutsu (?)					Cd		
		(not collected)	—						Cr	
	Dasyproctidae	*Cuniculus paca*	Nutasu (F), Walutsu (C)					Cd	Cr	
		Dasyprocta (prob. *punctata*	Duhsu	Fp						
		Dasyprocta (prob. *aguti*)	Durlu						Cr	
		Hydrochaeris hydrochaeris	Unsu		Fd					
Carnivora	Procyonidae	*Procyon cancrivorus*	—		F*					
	Mustelidae	*Eira barbara*	—		Fd					
	Felidae	*Felis concolor*	Yanala, Yanalatasu					Cd		
Perissodactyla	Tapiridae	*Tapirus terrestris*	Hanuntsu (F), Alũsu (C)	Fp	Fd					
Artiodactyla	Tayassuidae	*Tayassu pecari*	Yacatasu, Yakatatu		Fd	Fr			Cr	
		Tayassu tajacu	Yakisu, Yahtsu		Fd			Cd		

TABLE 1.—*Animal items used in the diet by the Alantesu village, in the forest (F), and the Juina village, in the cerrado (C), on the visits: previous (p), dry season (d) and rainy season (r).* (continued)

Scientific name Order	Family	Species	Nambiquara name	Place/season	Stage or part used
	Cervidae	*Ozotoceros bezoarticus*	—	Cr	
		Mazama americana	—	Fr	
		undet. 1	Kwhiditxu, Kwhitxisu	Fd	
		undet. 2	Yatahlu	Cd	

Fp = Oct 78, Fd = Aug–Sept 79, Fr = Dec 79 Jan 80, F* = Sept 85, Cp = Nov 78, Cd = Sept–Oct 79, Cr = Jan–Feb 80.

Souza 1920) and one to an anaconda (Lévi-Strauss 1948); consumption of these animals was not observed by me. Hugo (1959) reports the capture and dividing up of a two-meter-long alligator in 1944 (no alligator was observed in this research). Price (1981) mentions a large turtle; the turtles I observed were small and were unidentified as to species.

Giant anteater, tapir, puma, capybara, tayra, agouti, and collared peccary are confirmed as Nambiquara prey animals (Aytai 1981; Lévi-Strauss 1948; Roquette-Pinto 1975). Other animals with less precise identification such as armadillos, bats, deer, monkeys, rats, pigs and birds, are also mentioned by these sources as Nambiquara food. The bats referred to in this paper (Table 1) include a blood-feeding species (Setz & Sazima 1981, 1987). The rats (Rodentia) I observed were not identified, in part because of the poor material obtained, in part because of the scarce reference material from the Chapada dos Parecis region. Spines from the tropical porcupine *Coendou prehensilis prehensilis* were used for adornments and I suppose that the animal was eaten.

The Alantesu diet included 18 species of insects, 16 fishes, five reptiles, 11 birds and 19 mammals during the stay at this village. The Juina diet included 28 species of insects, eight fishes, three amphibians, six reptiles, 24 birds and 21 mammals during equivalent periods of observation (A: 69 spp., J: 90 spp.). The Juinas mentioned that they also eat "15 kg-armadillo"—probably the soft-tailed armadillo [*Cabassous unicinctus* (L. 1758)]. In another village, Campos Novos, at the Chapada dos Parecis the Nambiquara hunted a woolly monkey [*Lagothrix lagotricha* cf. *cana* (Humboldt 1812)] for food. In 1985 in a short visit with the Alantesu, I observed a racoon (*Procyon cancrivorus*) being prepared for consumption.

The use by the Juina of a larger variety of species may be the consequence of a lower average abundance of each species, therefore requiring less selectivity to obtain a given quantity of food within a reasonable span of time (Setz, in preparation). In addition, peccaries (*Tayassu* spp.) and capuchins (*Cebus* spp.), principal Alantesu items, are social animals that can frequently be harvested in groups. In contrast, larger savanna animals such as the giant anteater (*Myrmecophaga* sp.), the teiú lizard (*Tubinambis* spp.), the armadillos (Dasypodidae) and the deer (Cervidae), are generally solitary, or live in pairs, which diminishes the yield of these species per hunt. Although the RADAMBRASIL Project (Brasil 1979) mentions migratory birds for the region from October to December, the increase in bird species in the September-October Juina menu includes only four possibly migratory bird species (L.O. Marcondes Machado, pers. comm.).

Pets and domesticated animals are considered by the Nambiquara Indians as relatives and are not eaten. Alantesu villagers had one pet coati (*Nasua nasua*), two agoutis (*Dasyprocta* sp.), an infant black spider monkey (*Ateles paniscus*), a sub-adult howler monkey (*Alouatta seniculus*) and a young marmoset, possibly the pygmy marmoset (*Cebuella pygmaea*), as well as young Amazon parrots (*Amazona* spp.). The children also kept toads (*Bufo* spp.) for their amusement. Observations elsewhere in the Chapada dos Parecis revealed a pet titi-monkey (*Callicebus moloch*) at Cabeceira Village, a South American fox (*Dusicyon* sp.), as well as young amazon parrots (*Amazona* spp.), and unidentified young owls

(Strigidae) at Aldeia Branca Village. Lévi-Strauss (1948) reported a pet juvenile wooly monkey (*Lagothrix* sp.) and Allen (1916) a pet white nosed bearded saki monkey (*Chiropotes albinasus*) at other Chapada sites.

Collection and Processing of Foods of Animal Origin.—Insects, when abundant, can provide a valuable food source. However, because of their small size and peculiar behavioral characteristics, capture efficiencies can be dramatically increased by adopting specific capture techniques.

When a swarm of grasshopper nymphs (*Schistocerca* sp.) is detected by the Juina, usually in the rainy season, the gathering party is called together. Some of the women collect dry palm leaves and make bundles for torches. Surrounding the swarm, they beat the vegetation singeing the grass and nymphs. Other women dig a trench of about 30 cm wide and 120 cm long and 80 cm deep. Grasshoppers are herded so as to jump into the hole, from which they have difficulty escaping and can be gathered and put into baskets. Adult grasshoppers (*Rhammatocerus* sp.) are difficult to grab but may be knocked down with a switch. In the cool of early morning, big grasshoppers (*Tropidacris collaris* and *Lophacris* sp.) are encountered on trees and can be easily captured by hand, or by swatting with a stick when they are too high on a tree. The grasshoppers are toasted directly in the ashes of a cooking hearth (Fig. 2). They can be stored for two or three weeks in baskets, if kept dry. They are eaten without additional preparation or crushed into a flour, which can be mixed with fruit juice or added to crushed manioc bread ***("beiju")*** and eaten in handfuls.

FIG. 2.—A Juina woman toasting grasshoppers (*Schistocerca* sp.) in the ashes of a cooking hearth.

When the Juina sight a swarm of winged termites (Isoptera) in the evening, they give an alarm which mobilizes the entire village. Some pick dry palm leaves and others containers with water; everybody goes to the spot where the flight was seen. They set fire to the palm leaves and shake them in the air among the flying termites. Dropping termites are gathered and put into the containers with water, from which they are unable to escape. The insects are subsequently toasted among hot ashes, freed from the ash by sifting, and eaten.

Coleoptera and Lepidoptera larvae are much used as food in both villages. When clearing a new garden, cut palm trees are left to provide substrate for developing beetle grubs. The decaying pith attracts adult beetles that lay eggs in the decomposing heap. Jaracatia-grubs (Cerambycidae), much appreciated by the Alantesu, are gathered by women and children who beat cut stumps of *Jaracatia* sp. (Caricaceae) and then listen and sniff attentively. If there is evidence of grubs, they dig into the stump; a single stump can yield up to 50 larvae. The gathering ends only after careful inspection of all the stumps. The Alantesu collected colonial *Brassolis* caterpillars from a palm heap lying in the garden; these probably developed on the fronds of the living palm. Cerrado *Tabebuia* sp. (Bignoniaceae) trees with ***alanauhsu*** caterpillars (Sphingidae) were recognized by their defoliated state. Two saturniid larvae that were subsequently eaten were gathered from tree trunks in the Juina River riparian forest. Caterpillars and grubs are disemboweled by biting them behind their heads and removing the head and attached digestive tract with a quick pull. The prepared larvae are wrapped in wild banana leaves (*Heliconia* sp., Musaceae) and baked among hot ashes (Fig. 3).

FIG. 3.—Jaracatia grubs (Cerambycidae) and fermented manioc cake ready for eating.

Near both villages, as well as on the hunting grounds of the Juina, ants are harvested at well known leaf-cutting ant mounds (*Atta* spp., see Table 1). Ant gathering is practiced by women and children. Water containers and manioc bread are carried to the ant mound. On the way, a branch about 2 cm in diameter is selected and twigs and leaves are removed to make a smooth stick. This is thrust into the mound and the hole widened with a circular movement. When soldier ants climb about two thirds up the stick, it is held upright over the container and the ants stripped into the water. The stick is returned to the hole and the whole process repeated until a sufficient quantity of ants is collected. Some ants may be eaten raw on the spot, with pieces of manioc bread, discarding only the heads. At the village or camp, the ants, raw or toasted, are crushed in a mortar with manioc or corn bread for eating. Both the Alantesu and the Juina gathered ants in the rainy season.

Wasp larvae and pupae are almost always given to children to eat. They are collected with the aid of burning palm leaves and eaten alive one by one from the combs.

Bee honey is gathered by Alantesu men who make a firm scaffolding with branches to reach hives higher up. After smoking out the adult bees, stocked pollen, larvae and pupae are eaten without further preparation. Honey pressed manually from the combs is diluted in water and drunk. At the Juina, both men and women gather honey. Adult bees are driven away by the smoke from bundles of burning palm leaves (Fig. 4). Afterwards, still with smoke protection, a hole

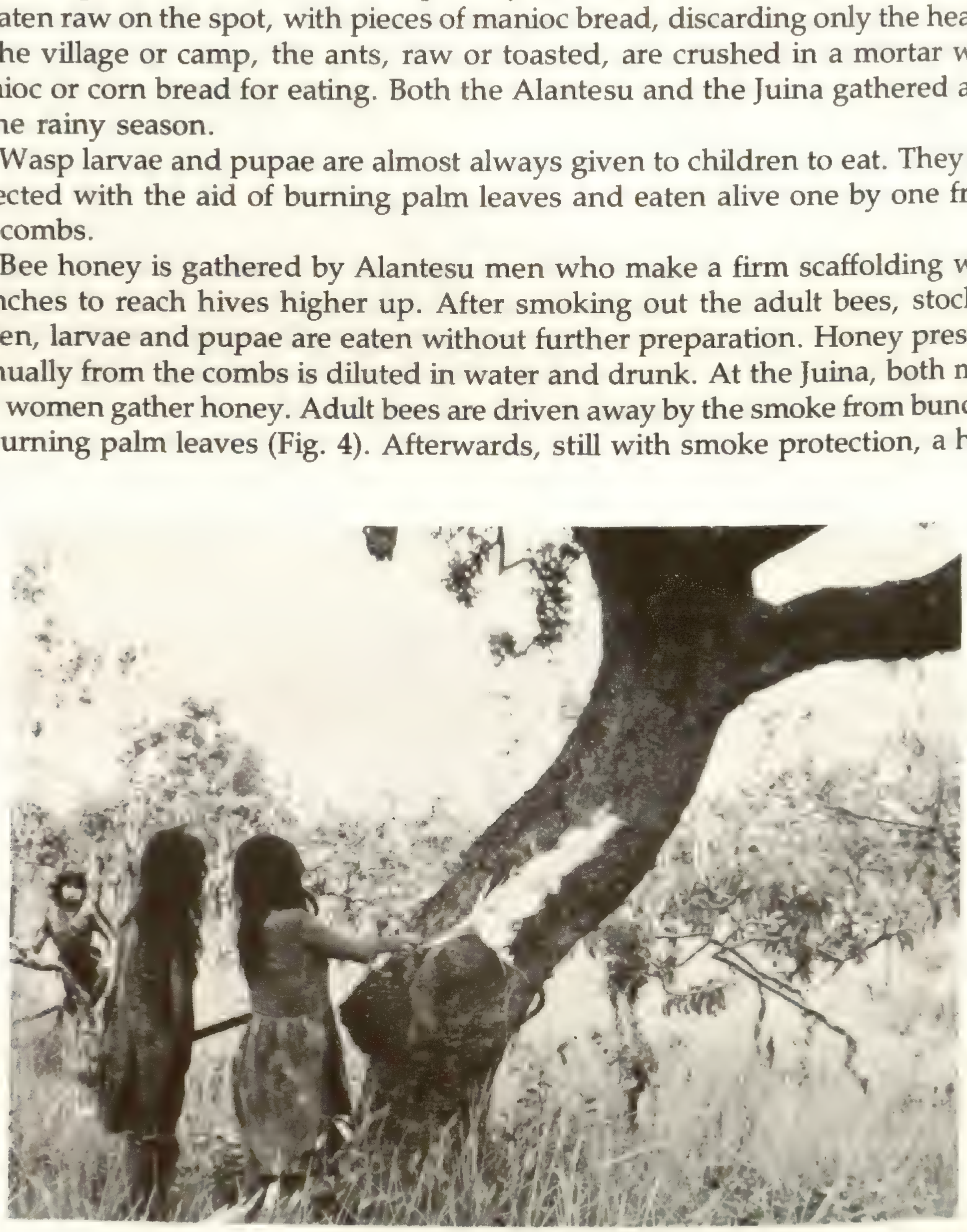

FIG. 4.—Two Juina women using torches to drive adult bees (*Lestrimellita limao*) away from their nest.

is cut in the tree trunk with an axe and the honey combs and stocked pollen put into a basket. In a case involving a tree more than 10 m tall, the procedure became more complicated. Women provided bundles of dry palm leaves, and a man climbed a neighboring tree using a climbing ring made of fibrous tree bark and carrying a bundle of palm leaves on his back. As he drove the bees away with the burning bundle, two companions felled the nest-tree. At the same time women prepared more palm-leaf bundles to drive bees away when gathering the stocked pollen and honey from the fallen tree. The use of honey and stocked pollen is identical to the Alantesu.

Various methods of fishing were observed. The Alantesu deposit tree trunks on the bottoms of creeks and lakes. Diving and examining these trunks regularly, they hand-gather fishes taking shelter there. In another type of fishing practiced by women, baskets are moved through the water in a group pattern to capture fish (*Hoplosternum thoracatum, Pterygoplichtys* sp.) dislodged from creek or lake margin vegetation. Both Alantesu and Juina men hunt fish, especially *Hoplias malabaricus,* with bow and arrow, using an arrow with a barbed point. Arrow caught fish are usually cut into pieces and used as bait in hook and line fishing. Coconut beetle larvae, earthworms, discarded parts of game animals and leafhoppers are also used as bait. Fishes may be attracted with fresh corncobs or corn husks thrown into the river. The men sometimes leave one or more baited lines in the creek or river overnight, and check them for fish the following morning. Women accompanied by children catch baitfish by walking in a creek where fish are corralled with a basket and picked up. Younger children help by beating the water surface, herding the fish, which are then caught easily. A method used by Alantesu children which gives more pleasure than food is "mud fishing." Children remove mud blocks from the bottom of small ponds and throw them onto the banks. Fishes living in the mud become dislodged (*Hoplerythrinus unitaeniatus, Aequidens* sp., *Erythrinus erythrinus, Callichthys callichthys, Hoplosternum thoracatum*) and are put into baskets. The Juina tell of fishing with ichthyotoxic plants (*Serjania* sp., Sapindaceae) in flood-plain ponds and small creeks. Neither the Alantesu nor the Juina make or possess boats. Both scaled fishes and armoured catfishes are baked whole on ashes. Unarmored catfishes are roasted wrapped in wild banana leaves. Afterwards, they can be peeled and mashed with cake in a mortar, or eaten as they are. The Juina preserve fish by smoking, and before eating them, cook them with sweet manioc or rice.

Various vertebrates which live in burrows underground e.g. lizards such as spiny-tailed iguana (*Hoplocercus spinosus*) and puffbirds (unidentified Bucconidae) are collected by digging. In the case of deep-nesting puffbirds two women may cooperate. The gallery is normally marked by threading a thin stick into the hole so as not to lose it in case of a cave-in. The pepper-frog (*Leptodactylus labyrinthicus*) and a yellow toad (not collected) were gathered in the same way. When an occupied armadillo burrow is found, one person listens by holding one ear close to the ground while another jumps to frighten the animal. When the armadillo moves, the listener detects its position and indicates where to begin digging. This is repeated until the animal is caught. Sometimes the person who listens also beats the ground and digs, and often someone else comes to help. If the digging takes a long time, the diggers and listeners alternate tasks.

In the cerrado, hollows in trees are examined in the search of opossums (Didelphidae) and nests of parrots and owls. Their occupants (eggs and adults) are valued items in the Juina diet. When a hollow tree with bats (Chiroptera) is found, both the Alantesu and the Juina use fire to dislodge them. Bats falling to the ground are caught and later roasted (Setz & Sazima 1981, 1987).

Many mammals are obtained by hunting. The Indians hunt with bow and arrow of two types. One, made from a wild cane, has a lanceolate bamboo blade with sharp edges for bigger game, and the other having a point consisting of a wooden knob is used to stun monkeys and birds. The effectiveness of the lanceolate arrows is considerably improved by curare, a plant derived poison, (see Véllard 1965). They also hunt with rifles. Bullets are made by melting and casting lead from sinkers. The Alantesu hunt in groups of five to nine men who patrol the forest during daylight, looking for tracks on the ground, signs on the vegetation, odors and feces, and for trees with ripe fruit on which game animals feed. They cautiously approach animals until they are near enough to shoot. The Alantesu also hunt from ambush (''caçada de espera''). In this case, men set out at sunset for some wallow and stay there all the night waiting for capybaras and tapirs to come by. The Juina baited for game. Around a spot having agouti tracks, a hunter makes a little clearing and places food on the ground. He returns over a number of days until he can shoot the animal. In a previously burned area of cerrado with sprouting grass (cf. Setz 1983c), the men look for deer tracks. When recent tracks are seen, women and children are called in to help track and surround the prey, which is then killed. When someone sees recent tracks of a giant armadillo or giant anteater, he calls several people to help track and capture the prey. The peccaries consumed by the Juina in the dry season were obtained by ''garden hunting'' (Linares 1976). The Juina let the peccaries come to feed in their fields for a few days and then kill many of them.

No type of trap was observed or reported to be used in either Nambiquara village. When the hunter catches an animal, he calls someone who is nearby to pick the animal up and transport it to the camp. If the animal is big, it is cut up in two or more parts, which are carried separately back to the camp or village. When many peccaries were killed, they were piled in a heap in one place, the village notified and women sent to bring them in.

The game processing is done at camp or in the village. First, the fur is burned off and the skin scrapped until very clean. The viscera are removed, cleaned and baked separately. The animal's body is tied using plant fibers, making a round package, and put among the hot ashes to roast. Nambiquara refuse to eat meat that is still bleeding; everything is roasted until well done. When well cooked, most of the meat (without skin and with some bones) is crushed in a mortar with corn cake, manioc bread or baked sweet manioc. It is separated into balls having a volume from about one to two handfuls, and distributed for eating. Very big prey (tapir, for example) are brought in pieces and distributed throughout the village, and each household roasts its portion. Birds are plucked clean, wrapped in leaves and roasted. Armadillos, tortoises and turtles are roasted in their own shell. Tortoises not consumed at once are kept alive. They are tied by their shells and hung from the roof. Eggs, in general, are eaten baked. A little puncture is made in the shell of the egg before it is placed among hot ashes.

The Juina participate in hunting treks, and during these they store the best parts of the game for eating upon return to the village. First, they prepare charcoal in a pit near the camp for roasting pieces of game. This roasting can take all night, and is taken care of alternately by two or three men. Afterwards, the roasted meat is preserved by smoking day and night on a rectangular grill over a fire at each camp.

No type of seasoning (salt, or other) was used in the preparation of any food consumed by the Nambiquara. Lévi-Strauss (1963) mentions that the Nambiquara "cannot bear to eat salt, which they do not know to prepare, or pepper, which they do not cultivate." He describes however the use as a condiment of a type of "cumaru" bean (*Dypterix* sp., Leguminosae) which give a strong, bitter almond taste.

CONCLUSIONS

Although similar methods are used to obtain and process animal items, the two villages (A and J) presented clear differences in the taxonomic composition of animal foods (A, more fishes; J, more insects and birds, for example) and the total number of species (A: 69 spp. vs. J: 90 spp.) observed in the diet during standardized observation periods. Qualitative and quantitative differences in the fauna of the two environments may largely explain the dietary differences and the cultural fixation of particular hunting, fishing and collection methods.

The methods by which the animals or animal items are obtained and processed in the two villages were similar not only because the two populations showed the same basic culture but also because of the similarity in behavior of the animals available for consumption.

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NOTES

[1]Orthoptera (grasshoppers)—C. Carbonell, Museu Nacional, Rio de Janeiro, RJ; Isoptera (termites)—E.M. Campelo, Museu Zoologia da Univesidade de São Paulo (MZUSP), São Paulo, SP; Lepidoptera (butterflies)—C.F.S. Andrade, Universidade Estadual de Campinas (UNICAMP), Campinas, SP and M.M. Dias Filho., Universidade Federal de São Carlos, São Carlos, SP; Coleoptera—T.M. Lewinsohn (UNICAMP), U. Martins and S. Vanin (MZUSP); Hymenoptera (ants)—H.C. de Moraes, Universidade Nacional de Brasília, Brasília, DF, (wasps)—P.J. Moure, Universidade Federal do Paraná, Curitiba, PR, (bees)—J.M.F. Camargo, Universidade de São Paulo (USP-RP), Ribeirão Preto, SP and P.J. Moure; Fishes: I. Sazima (UNICAMP) and H. Britski (MZUSP); Amphibians and Reptiles—I. Sazima; Birds—L.O. Marcondes Machado, J. Vielliard (UNICAMP) and Werner Bokermann, Fundação Parque Zoológico de São Paulo, São Paulo, SP; Mammals

in general—C.T. Carvalho, Instituto Florestal da Secretaria da Agricultura de São Paulo, São Paulo, SP; bats—I. Sazima; Callithricidae—M. Becker, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Florianópolis, SC; Cebidae—M. De Vivo (USP-RP).

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BOOK REVIEW

Le Rizen en Asia du Sud-est. Atlas du Vocabulaire de la Plante. Nicole Revel with the collaboration of Alexandra Laclau, Marie–Claude Lortic, Catherine Zacharoupoulou. Editions de L'Ecole des Hautes Etudes en Sciences Sociales, Paris. 1988. Fr. 550.

This monumental contribution to our knowledge of the world's most important grain—rice—will be of extraordinary interest to ethnobotanists working in southeast Asia, and it is destined to be a valuable tool for the Rice Institute of the Philippines. The great amount of field and literature research represented in this publication is difficult even to envisage.

In tabular form, the various terms connected with rice are set forth for 21 groups of languages with numerous languages and dialects in these linguistic or geographic groups. For each linguistic entry there are terms applied to rice in various forms: the plant itself; unhusked rice; husked rice; the cultivated plant; rice soup; glutinous rice; non–glutinous rice. The main volume of this publication consists of 53 pages of tables with these terms.

This volume is accompanied by 78 supplementary maps indicating the areas of use of the many terms outlined in the principal tabular offering, including the several terms for the seven aspects of rice and its characteristic uses.

It would be difficult to point out any similar study on any economic plant for any other part of the world. The many researchers must be congratulated for producing a highly praiseworthy contribution to science.

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MANAGING DIVERSITY IN POTATO AND MAIZE FIELDS OF THE PERUVIAN ANDES

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ABSTRACT.—This paper examines the management of mixed-cultivar (polycultivar) fields in the Andes of Southern Peru. It focuses on the two field systems used to produce native potatoes (*Solanum* spp.) and maize (*Zea mays* L.). The organization of diverse cultivars within fields and the context of diverse-cultivar fields in peasant farm production are analyzed from a human-geographic "landscape perspective."

Research findings indicate that contrasting selection practices guide polycultivar agriculture in each crop. Potato diversity is maintained primarily through the selection of morphologically distinct cultivars that leads to high and notably uniform levels of diversity within fields (mean 21.1 cultivars/225 plants; standard deviation 5.1). The maintenance of diverse potato cultivars serves to reproduce socio-cultural signs of Quechua identity. Maize cultivars number fewer per field (mean 2.9 cultivars/field) and are chosen individually for specific traits linked to consumption and production. Different modes of selection in each crop correspond to contrasting rates of biological recombination.

Polycultivar fields of potatoes and maize are differentiated according to a little-recognized grouping referred to as "use-category." "Use-category" is a utilization-based ranking at the supra-cultivar level that specifies the taxonomic composition and location of fields. The continuation of "use-category" management is a requisite for *in situ* crop conservation.

RESUMEN.—Este artículo trata el manejo de chacras (ó campos) de variedades mezcladas (referido como chacras policultivadas) en la parte sur de los andes peruanos. El artículo lleva un enfoque sobre los dos sistemas utilizados para cultivar la papa (*Solanum* spp.) i el maíz (*Zea mays* L.). Tanto la organización de variedades diversas dentro de las chacras como el contexto de chacras policultivadas dentro de la producción campesina son analizados desde una perspectiva de la geografía humana.

Los resultados de la investigación indica que la papa y el maíz difieren en cuanto de practicas para la agricultura policultivada. En la papa la elección de singularidad morfológica sirve para mantener una diversidad dentro de las chacras la que es alta y notablamente uniforme (promedio 21.1 cultivos/225 plantas; error normal 5.1). El manenimiento de las variedades diversas de papa proviene signos socio-culturales de la identidad quechua. Los cultivos del maíz por chacra alcance un numero bastante menos (promedio 2.9 cultivos/chacra) y son escogidos individualmente por characteristicas especificas del consumo y producción. Los sistemas diferentes de elección de cultivos de papa y maíz relaciona con tasas distinctas de recombinación biológica en cada uno.

Chacras policultivadas de papa y maíz son diferenciadas según una agrupación poco conocida llamado la "categoría de uso," la que es una clase definido por uso que especifica la composición taxonómica y la ubicación de chacras. La continuación del manejo por "categoría de uso" es necesario para la conservación *in situ* de cultivos nativos.

RESUME.—Dans cet article on va examiner la direction des champs des Andes du sur du Peru qui ont de la cultivation mélangée. On met en pris les deux systèmes des champs employés pour produir des pommes de terre natives (*Solanum* spp.) et du maïs (*Zea mays* L.). On analyse la cultivation des divers cultivars dans les champs et le contexte des champs de cultivation mélangée chez l'agriculture paysanne d'un perspectif de la géographie humaine.

Les resultats de la recherche indiquent que les practiques contrastanes de la selection guident l'agriculture mélangée avec chaque récolte. On maintient la diversité des pommes de terres par la selection des cultivars morphologicamment divers, qui produit un niveau haut et uniform de diversité culturel dans la plupart des champs (moyen 21.1/225 plantes, erreur normal 5.1). La maintenance des cultivars divers de la pomme de terre produit des signes socio-culturel de l'identité Quechua. Les cultivars du maïs sont de diversité plus bas (2.9 cultivars/champ) et on les choisit selon les caractères spécifiques de la consumption et la production. Les divers modes de selection chez chaque récolte correspondent aux taux contrastants de la récombination biologique.

On distingue entre les champs mélangés du maïs et de la pomme de terre selon les groupes peu connus qui s'appellent les "catégories d'usage," qui son les classes de rang plus haut que les cultivars, definis selon l'usage qui specifie la composition taxonomique et l'emplacement des champs. La continuation de la direction des "catégories d'usage" est nécessaire chez la conservation *in situ* des récoltes natives.

INTRODUCTION

The maintenance of diverse crop cultivars hinges on the management practices of agriculturalists. In the tropical montane environments of the Peruvian Andes, Quechua peasants cultivate the world's most genetically diverse assemblages of cultivated potatoes and maize (Grobman *et al.* 1961, Vavilov 1926). Several comprehensive studies deal with the ecology and ethnobotany of these crops in highland Peru (e.g., Bird 1971, Gade 1975). With the notable exception of Brush *et al.* (1981), few field investigations have focused on agricultural management of the mixed-cultivar (polycultivar) fields employed by Andean farmers in maintaining the diversity of native potatoes and maize. Notwithstanding the paucity of studies aimed at the polycultivar planting of these particular crops, ethnobotanical research increasingly has addressed the management of such parcels and the associated maintenance of diverse cultivars (e.g., Boster 1985, Clawson 1985, Johannessen *et al.* 1970).

The present study examines the management of polycultivar fields of potatoes and maize in the highland Paucartambo region of Peru's southern Andes (Fig. 1). It follows the perception–selection–maintenance–dispersal model of Johannessen *et al.* (1970) to describe the wide array of relevant agricultural management prac-

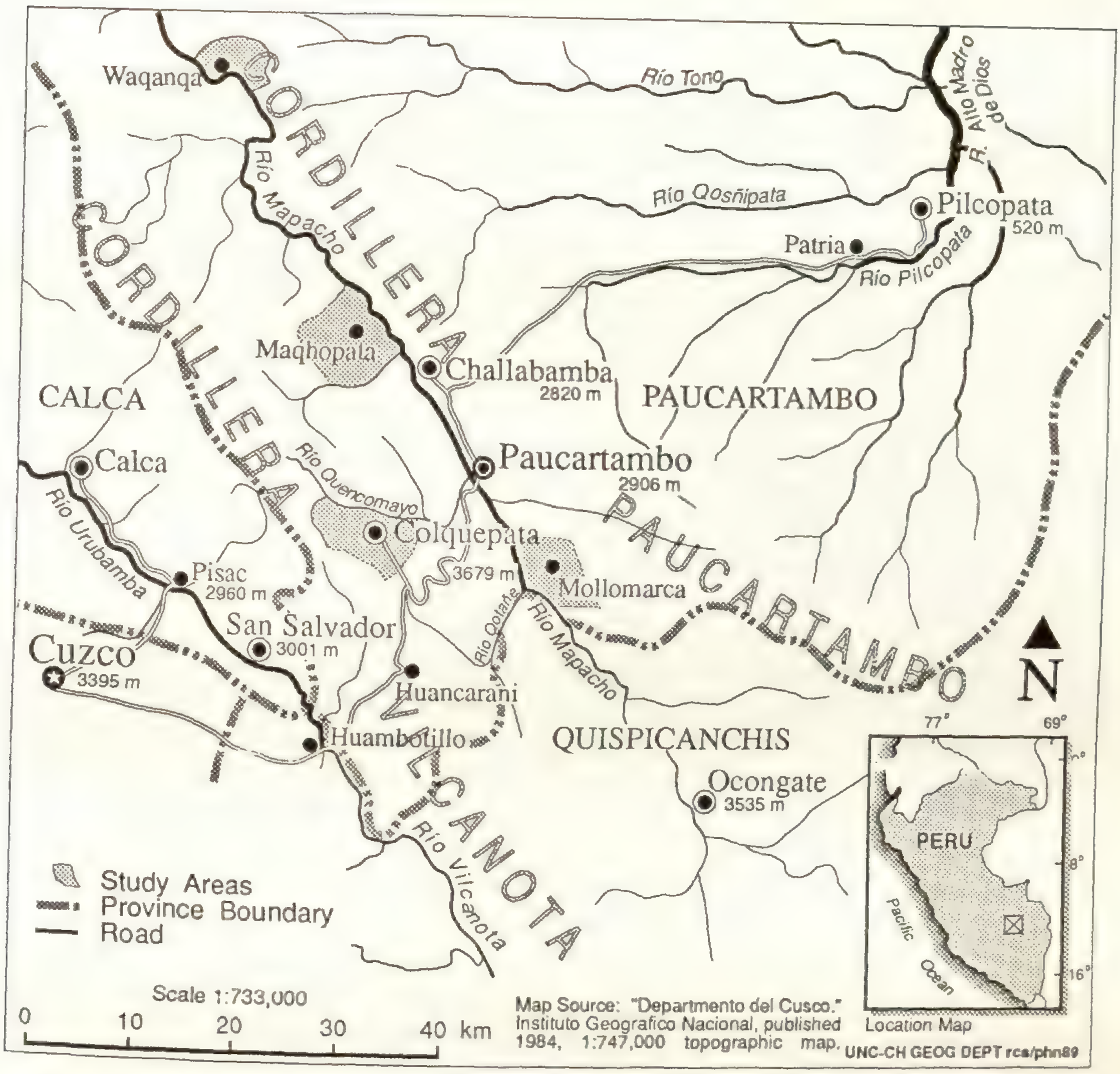

FIG. 1.—Study areas in highland Paucartambo.

tices. One principal goal of the study is to evaluate the applicability of existing explanations concerning how and why cultivar diversity is managed within polycultivar fields of both crops (potatoes and maize). The second major aim is to develop a comprehensive conceptual framework for understanding the multi-faceted management of polycultivar agriculture. The study formulates a human-geographic "landscape perspective" that complements the ecological and perceptual-cognitive foci that form necessary but not sufficient accounts of the agricultural management of cultivar diversity.

Two contrasting explanations concerning the selection of intra-specific diversity need to be compared in examining potato and maize agriculture in the Andes. Discussing the substantial genetic diversity of Andean potatoes, Brush and Guillet (1985:24) summarize the first of the proposed explanations in the following manner: "Selection matches agronomic qualities [of cultivars] to microenvironmental conditions." Bird's (1971) interpretation of management practices utilized in Andean maize production similarly highlights the direct selection of diverse

cultivars for agroecological objectives. The second explanation, and a notable contrast to the selection of cultivar diversity for agroecological rationales, is Boster's (1985) model of selection based on perceptual differences. Boster proposes that the large number of manioc cultivars in western Amazonia is ''a result of people's efforts to distinguish and maintain the cultivar inventory'' (Boster 1985:310). He suggests that a similar explanation applies to diverse assemblages of other tuber-bearing crops such as Andean potatoes. The present study's close examination of the two proposed explanations for diverse-cultivar management shows that the majority of potato cultivars in polycultivar fields are selected for perceptual distinctiveness whereas maize types are selected directly for consumption and production traits. The resolution of agricultural selection, however, does not fully explicate the maintenance of cultivar diversity.

Few frameworks have been proposed to deal comprehensively with the management and maintenance of cultivar diversity. One exception is a model that combines the perception, selection, maintenance, and dispersal of crops (Johannessen 1966: Johannessen *et al.* 1970). Although it encompasses the gamut of activities involved in managing polycultivar fields, the model does not specifically address the combination of ecological-economic (production, consumption) and socio-cultural (symbolic meanings) considerations that are likely to underpin the agricultural practices of peasant farmers. The present study adopts a human-geographic ''landscape perspective'' in order to view polycultivar agriculture as representing both the economic and socio-cultural strategies organized by rural inhabitants.[2] Identifying these strategies as contingent relations in the human modification of ecological processes is thought to remain an unrealized imperative for ethnobiology (Ellen 1986:89).[3] A central finding of the present study is that several characteristics of cultivar management actually are based on a supra-cultivar level of classification referred to as the use-category, a contextual designation that specifies the parcel's taxonomic composition, ecological location, and utilization.

The ''landscape perspective'' is used also to integrate the material (ecological-economic) and symbolic objectives involved in the management of multiple cultivars within single fields, thus avoiding an exclusively economistic view of subsistence food production. Landscape features are known to serve as important symbols in the everyday lives of Andean peasants. Allen's (1988) recent ethnography of a community in the Southern Peruvian Andes illustrates how landscape elements, many of them evincing human modification, are commonly attributed with symbolic meanings. These symbols, at first glance representing portions of the ''natural setting,'' are used by highland Quechua to interweave cosmological beliefs and group social identity vis-a-vis outsiders. Yet highland Andean environments are not simply ''natural'' or even a ''setting'' but rather largely reflect the result of human labor ensuring inhabitants' survival. Polycultivar fields need to be viewed as one of several landscape elements forged by the combination of ecological-economic and socio-cultural practices. The present study finds that agriculturalists maintaining polycultivar fields imbue native cultivars, especially potatoes, with a symbolic importance that helps explain why selection for perceptual distinctiveness occurs.

This article begins by reviewing the study of diverse-cultivar maintenance and the management of polycultivar fields. It examines the extent to which existing explanations account for the following three interconnected aspects of polycultivar agriculture: the objectives of agriculturalists, their practices, and the biological properties of cultivars and field ecology. The second section introduces the study area, crop species, and field research methodology. The third and fourth parts present research findings concerning the maintenance and diversity of Andean potatoes and maize, respectively. Here I attempt to explain the maintenance of diverse cultivars and polycultivar fields by integrating the three central areas of inquiry introduced in the opening section. Finally, the concluding section discusses the limitations of existing explanations and proposes incorporating them into a more flexible framework, or "landscape perspective," that emphasizes the economic and social contexts entrained in the reproduction of polycultivar fields. It argues that this broader vision is a necessary part of the successful design of *in situ* programs for crop conservation.

STUDIES OF POLYCULTIVAR AGRICULTURE

Research in several disciplines, including agronomy, economics, geography, and anthropology, cultural and human ecology, and ethnobiology, has addressed the maintenance of multiple crop cultivars in peasant agriculture.[4] The majority of studies have examined the composition and ecology of fields containing diverse cultivars and species by focusing on the questions of which taxa characterize such parcels and why they are planted by agriculturalists. Polycultural fields, a term referring to mixtures of cultivars as well as species, have been found to hold many ecological advantages over monocultures: "Generally polycultures are more productive, utilize soil resources and photo-synthetically active radiation more efficiently, resist pests, epidemics, and weeds better ..." (Altieri *et al.* 1983:46).

The ecological benefits of polycultivar agriculture, especially the reduced risk of crop loss, frequently have been used by researchers to explain why farmers maintain diverse-cultivar fields. These accounts cite either presumed or demonstrated variation in the ecological properties of diverse cultivars, combined with the supposed reluctance of peasant farmers to adopt new technologies, as evidence of management motives based on averting risk and otherwise ensuring harvest (e.g., Altieri and Merrick 1987, Clawson 1985). Contrary interpretations, however, have arisen from economic analyses of decision-making among small-holder agriculturalists. Findings concerning peasant agriculturalists' economic behavior offer little support for risk-aversion as a guide to most of their farm practices (Binswanger *et al.* 1984, Roumasset *et al.* 1979). Thus, although polycultivar fields presumably reduce farm risk, it is unfounded to assume that this function necessarily motivates agriculturalists' decisions about planting.

Various claims for the directed selection of individual taxa in the polycultivar field emphasize ecological motives other than risk aversion *per se.* One example is specialization to climatic or edaphic conditions (e.g., Harlan 1975a). Such explanations too are often based on deductive logic, purported rationales tending

to be imputed rather than verified. They frequently draw on observations by Sauer (1952) and others that tuber–bearing domesticates and New World cereals are planted individually in polycultivar fields rather than through broadcast sowing. To deduce the intent of agriculturalists based on the form of field composition, however, is to assume the concurrence of the two phenomena. Ethnobiologists have pointed to the epistemological fallacy of assigning motives to human actions based solely on their consequences, biological and otherwise: ''The argument [for adaptation] is trivial when the usefulness of an item of cultural knowledge is deduced from the fact of its existence, tautologically, then 'explained' by analytic tour de force'' (Hunn 1982:831; also see Hays 1982).

The question of how agriculturalists select diverse cultivars has been examined less than field composition and cultivator rationale. To date, a pair of quite different interpretations of how agriculturalists choose diverse cultivars have based their contrasting arguments on the striking divergence of seed and tuber color among intra–specific cultivars during the course of crop evolution. Most authors have asserted that color and other non–adaptive characters serve as morphological ''markers'' that flag agroecologically favorable traits such as drought or frost tolerance that otherwise would remain visually indistinguishable (Clawson 1985, Harlan 1975a). According to the ''marker'' explanation, agriculturalists select for and then maintain the morphological diversity of cultivars in pursuit of agro-ecological objectives.

Boster (1985) has formulated the most significant alternative to the ''marker'' thesis. Investigating the selection of diverse manioc cultivars in western Amazonia, he found that Aguaruna agriculturalists select and maintain cultivars possessing distinct morphotypes. His results support a proposed model of ''selection for perceptual distinctiveness.'' Although Boster speculates that selection for morphological diversity might result in ecologically variable cultivars—essentially the inverse of evolutionary cause–effect proposed by the ''marker'' explanation—the question of why agriculturalists choose perceptually distinct cultivars appears not to have been a major inquiry in his research.

In summary, evidence from several perspectives indicates that ethnobotanical study needs to resolve and augment currently contradictory and incomplete interpretations of diverse–cultivar agriculture. A conceptual chasm frequently separates the two questions of why and how cultivators maintain polycultivar plantings. Arguments based on agroecological rationales lack supporting evidence about how such cultivars are selected. Conversely, a ''selection for perceptual distinctiveness'' model does not account for why agriculturalists undertake such practices. Finally, with a few exceptions, interpretations of polycultivar agriculture have primarily considered the selection of propagules without examining other activities that shape the management and maintenance of diverse cultivars.

Johannessen and his colleagues have posited a model of the domestication process in crop species that delineates four fundamental agricultural activities: ''perception of differences, selection for improvement; maintenance of improved genotypes; and dispersal of improved varieties'' (Johannessen *et al.* 1970:394). A similar framework was adopted by Brush *et al.* (1981:71) to assess the contemporary dynamics of potato agriculture in the Central Peruvian Highlands. Applied

to the management and maintenance of diverse cultivars, the Johannessen model offers the most comprehensive framework for linking the questions of why agriculturalists produce diverse native cultivars, how they manage diverse cultivars, and what comprises resulting field composition and cultivar characteristics. The following discussion examines the broad scope of agricultural activities circumscribed by the perception–selection–maintenance–dispersal model while emphasizing the relations between polycultivar management and its economic and socio-cultural contexts.

THE STUDY AREA, CROP SPECIES, AND METHODOLOGY

The study area of highland Paucartambo forms an easterly segment of the Southern Peruvian Andes (Fig. 1). A prominent inter–Andean valley carved by the Mapacho River roughly bisects the region and deeply dissects its upland topography. Highland Paucartambo supports approximately 20,000 rural Quechua–speaking inhabitants (known to one another as ***runa***), most of whom belong to peasant communities consisting of between 20 and 150 families. Socio–economically and politically subordinate, peasants of the region carry out a variety of "everyday practices" that contest the conditions of their material and symbolic domination by small groups of regional elite (known to peasants as ***mistis***) (see Allen 1988). Agriculture is the main occupation of rural inhabitants in the region. Relying on an amalgam of native and introduced crops and technologies, cultivators produce a portion of household subsistence as well as surplus for marketing.

Fields ranging from the base of sharply incised gorges at 2800 m to the high-elevation plateau at 3900–4100 m are possessed by the majority of peasant cultivators in highland Paucartambo. Their access to a wide range of contiguous elevational environments characterizes the so–called compressed–type of Andean zonation (Brush 1976:161). Potatoes, which comprise the most important crop in the region on the basis of measures such as area, labor inputs, and production, cover most agricultural areas above 3800 m. The production of maize fields, in contrast, contributes significantly less than potatoes to the subsistence and commercial economies of households due to environmental constraints that limit its cultivation to canyon slopes below 3500 m. Nonetheless, the maize crop is coveted by peasants for consumption and ritual use.

The breeding systems and genetic architecture of potatoes and maize present cultivators with contrasting biological templates. Domesticated mostly in the Central Andes (Bolivia, Peru, Ecuador), potatoes comprise a complex of eight related species (Hawkes 1978). Seven of these eight taxa occur in highland Paucartambo, although one (*Solanum phureja* Juz. et Buk.) is endemic to humid environments that are uncommon in the region. The areally less restricted distributions of the remaining six species—two diploids (*S. stenotomum* Juz. et Buk., *S. goniocalyx* Juz. et Buk.) and four polyploids (*S. x chaucha* Juz. et Buk., *S. tuberosum* L., *S. x juzepczukii* Buk., *S. x curtilobum* Juz. et Buk.)—are limited primarily by elevation. Of the six widely distributed taxa, four species (*S. steno-*

tomum, S. goniocalyx, S. x chaucha, S. tuberosum subsp. *andigenum*) contain thousands of native cultivars or land races.[5]

Maize (*Zea mays* L.), which probably was domesticated in Mesoamerica (Iltis 1983), reached South America at least as early as 2,000 B.C. (Zevallos *et al.* 1977). The crop subsequently diverged into so many sub–specific forms that the Central Andes, and Peru in particular, today contain the world's greatest diversity of maize types (Grobman *et al.* 1961). Cultivar formation and maintenance in maize, characterized by the strong tendency for sexual recombination via outcrossing, are shaped by the crop's monoecious habit and various cytological and genetic characteristics such as heterosis. In domesticated potatoes, on the other hand, the rate of adoption of sexual recombinants and hence that of cultivar formation is severely restricted due to the predominance of vegetative propagation. Furthermore, only diploid species in the series of potato domesticates show high rates of sexual recombination.

Field research was conducted between February 1986 and July 1987 in four study areas of highland Paucartambo (Fig. 1). Each study area included one or more peasant communities. Agricultural practices related to diverse–cultivar production were investigated using participant–observation. The author and an assistant also interviewed agriculturalists concerning their preference, classification, exchange, and identification of potato and maize cultivars. Ecological sampling was carried out in polycultivar fields of both crops.

POTATOES

Context.—Most cultivators in highland Paucartambo annually produce between three and six fields of potatoes that together cover .5–1.5 ha.[6] Potato production is organized according to four "production zones" (see Mayer 1985), each characterized by a specific or sub–specific taxonomic grouping of potatoes, agricultural environment, and production calendar (Table 1).[7] Fields of "improved" potatoes (*S. tuberosum* subsp. *tuberosum*) characterize the inner–canyon and intermediate–elevation production zones between 2800 m and 3800 m (***kheshuar*** and ***yunglla***, respectively). The same subspecies distinguishes the "early planting" production zone (***maway***) which is interspersed within the first two zones. The highest agricultural zone (***loma***) is divided between an upper and lower part. Fields of bitter potatoes (*S. x juzepczukii* and *S. x curtilobum*) are located in the upper section (4000–4150 m).

Potato fields in the lower tier (3800–4000m) of the high-elevation production zone (***loma***) contain the vast majority of biologically diverse potato cultivars in the study region. They are planted with mixtures of native cultivars belonging to as many as four species (*S. stenotomum, S. goniocalyx, S. x chaucha,* and *S. tuberosum* subsp. *andigenum*). Selection, propagation, and storage activities underpin the maintenance of these diverse cultivars. In addition, the exchange of tubers of native cultivars is needed once every five or six years to replenish the household's supply, thus contributing to the continuation of cultivar diversity in fields.[8] The various management activities responsible for the taxonomic composition of polycultivar fields in the low ***loma*** result in a strikingly consistent

species composition as listed above. Rather than occurring as a "natural" phenomenon, the elevational distribution of cultivated potato species is shaped by cognitive categories, representing the different uses of specific taxa, that guide farmer's practices.

TABLE 1.—*"Production Zones" of Potato Agriculture in Highland Paucartambo.*

"Production Zone" (Dominant Crop)	Potato Taxa	Elevation Limits (meters)	Calendar	Use-Category
Kheshuar (Maize)	improved vars. *(S. tuberosum* subsp. *tuberosum)*	3100-3500	Nov 15–May 1	"money"
Yunglla (Potatoes)	improved vars. *S. tuberosum* subsp. *tuberosum* some mixed native cultivars (see ***Loma*** below)	3500-3800	Oct 15–May 15	"soup-making"
Maway (Potatoes)	improved vars. *(S. tuberosum* subsp. *tuberosum)*	3100-3800	July 15–Feb 15	"money"/ "soup"
Loma (lower) (Potatoes)	*S. stenotomum, S. goniocalyx, S. x chaucha, S. tuberosum* subsp. *andigenum*	3800-4000	Oct 15–June 1	"boiling"
Loma (higher) (Potatoes)	*S. x juzepczukii S. x curtilobum*	4000-4150	Sept 15–June 1	"freeze-drying"

The taxonomic composition of polycultivar potato fields relates to ecological habitat and production zone location via cognitive categories subsequently referred to as use-categories (Table 1, far-right column). Each use-category specifies potatoes for a distinct purpose: freeze-drying, boiling, commerce, and soup-making.[9] In the highest fields (4000–4150 m), agriculturalists plant only freeze-drying cultivars (***ruk'i*** or ***chunu papa***). Fields in the lower portion of the high-elevation zone 3800–4000 m), discussed in the preceding paragraph, contain potato cultivars suitable for boiling (***wayk'u papa***). Fields of the remaining zones (***yunglla, kheshuar, maway***), whose production is destined for market, primarily yield "money potatoes" (***qolqe papa***). Subsistence production from the latter zones is used for soup-making (***bondon papa***). Use-category is the classification level

most critical to the management of polycultivar fields in the overall context of peasant production. Classification and naming at other levels, however, provide insights into agricultural practices such as selection that shape within-field dynamics.

Classification, naming, and selection.—The cultivators of highland Paucartambo classify potatoes according to four taxonomic groups: "crop," "use-category," "cultivar," and "sub-cultivar" (Table 2).[10] La Barre (1947:84) was the first to note that potato naming might reflect a hierarchical organization of these four categories.[11] Later, in research on potato agriculture in the Central Peruvian highlands, Brush's (1981) team used the proposed universal folk taxonomy of Berlin and his botanist collaborators (Berlin *et al.* 1973, 1974) to assign the four above-mentioned groups a parallel series of "folk taxonomic ranks," i.e., genus, species, variety, and sub-variety. Potato naming and classification in highland Paucartambo show several incongruencies with the postulated universal model, differences that are important for understanding the management of polycultivar fields.

Table 2.—*Folk Taxonomic Classification of Potatoes in Highland Paucartambo.*

Crop	Use-Category	Cultivar	Sub-cultivar
			yana chequefuru
	wayk'u papa	*chequefuru*	*puka chequefuru*
			yuraq chequefuru
		mariva	
papa	*bondon papa*	*yungay*	
		mi Peru	
			yuraq k'usi
	chunu papa	*k'usi*	*yana k'usi*
			moro k'usi

Potato naming in the study region violates an important rule of the proposed universal model which stipulates that "nomenclature is a near-perfect guide to folk taxonomic structure" (Berlin *et al.* 1973:216). In particular, the model specifies that folk varieties are labelled by secondary lexemes, i.e., two-word names in which one word refers to the immediately inclusive category. Yet, agriculturalists in highland Paucartambo, as well as the Central Peruvian Highlands (Brush 1980), do not use secondary lexemes (e.g., post oak, white oak) to name cultivars. Instead they utilize primary lexemes such as ***chequefuru*** and ***chimako*** (see Table 2). The practices of Paucartambo peasants diverge yet further from the universal model in adding an extra taxonomic level, the folk sub-variety (e.g., ***yana cheqefuru, yuraq cheqefuru***). The prevalence in everyday usage of sub-variety labels demonstrates the high level of precision employed by local agriculturalists in nam-

ing potatoes. A precise indigenous system is equally evident in the classification system applied to potato crop.

The classification of potato types in highland Paucartambo only partly resembles the hierarchical relations portrayed by the proposed universal folk taxonomy (Berlin *et al.* 1973, 1974). Non-exclusive taxonomic relations point to considerable flexibility in classifying. Certain cultivars classified as members of the "boiling potato" use-category (***wayk'u papa***), for instance, can also be assigned to the "soup-making" class (***bondon papa***). The non-exclusive property of the local folk taxonomy suggests "heterarchical" rather than hierarchical relations within the classification system (see Hunn 1976 for a discussion of the exclusivity problem in folk taxonomy). Despite evidence of incongruences, results of the field study concur with the proposal for a universal model in finding that the taxonomic groups identified by cultivators generally correspond to biologically important divisions. In particular, the rank of use-category (the folk-taxonomic species) is used to distinguish biological species (see Table 1, also LaBarre 1947:87, Gade 1975:206-207, Brush *et al.* 1981:71) while cultivar and sub-cultivar (variety and sub-variety in the folk-taxonomic schema) represent sub-specific biological categories that have been referred to by the same names (Harlan and deWet 1961; see footnote 5).

Agriculturalists identify the use-category, cultivar, and sub-cultivar affiliation of a given tuber based on morphological differences. They particularly use tuber shape, eye characteristics, and water content of the flesh to distinguish among use-categories and cultivars.[12] Most sub-cultivars, on the other hand, are distinguished from one another solely on the basis of skin color. Furthermore, whereas the names of use-categories indicate properties related to utilization, labels of cultivars and sub-cultivars do not refer to consumption or even production attributes. Instead, approximately one-half of the commonly used sub-cultivar labels refer to landscape and social features (Table 3).

TABLE 3.—*References Indicated by Potato Names in Highland Paucartambo.*

Landscape References		Social References	
paqocha senqa	"alpaca nose"	***misti pichilo***	"penis of a ***misti***"
condor runtu	"condor egg"	***ch'ilkas warmi***	"***ch'ilkas*** woman"
puma runtu	"puma testicles"	***qachum waqachi***	"that which makes the daughter-in-law cry"

Referential names attached to many cultivars are not only colorful and a topic of amusement and discussion among agriculturalists but they also incorporate prominent symbols of the local landscape. Many referential labels (e.g., ***paqocha senqa, condor runtu, puma runtu,*** see Table 3) describe landscape elements characteristic of the high-elevation grassland, or ***loma*** as it is known in the study region. Quechua peasants attribute spiritual power and closely link their social and cultural identities to this environment (Allen 1988). Other names (e.g., ***qachum***

waqachi, misti pichilo, ch'ilkas warmi) specify social groups within the region. Usually a tuber attribute, frequently shape or color, at least partly resembles the object to which the common name refers.

Consistency of identification determines the degree to which agriculturalists might control the composition of polycultivar fields. Among cultivators of common beans (*Phaseolus vulgaris* L.) in the Northern Peruvian Andes, for instance, pronounced variation in identification was found to be associated with a near absence of the direct selection of cultivars, thus preventing close management of field composition (Zimmerer 1985). In contrast, the identification of potatoes in highland Paucartambo varies little. Agriculturalists recognize and readily identify those cultivars that they plant. In the sampling of over 6,000 tubers in 26 fields, as discussed below, owners' identifications could be doubted only on a few occasions.

Notwithstanding their detailed knowledge of cultivar identification, most highland Paucartambo agriculturalists employ selection and storage practices that mainly involve the recognition of use–categories within the native potato crop rather than more precise taxonomic ranks. In either the field or storehouse (Fig. 2), tubers within each use–category are separated on the basis of size into the following groups: (1) "first class" (referred to locally as ***primera clase***) consists of large tubers which are displayed proudly before sale or household consumption; (2) "second class" (***segunda clase***) contains medium–large tubers that are either sold or, ideally, used for seed; and (3) "third class" (***tercera clase***) comprises relatively small tubers to be consumed by the household. (Sometimes a fourth category of yet smaller tubers is designated for freeze–drying as ***chunu*** or feed for the household's animals.) Individual cultivars are not culled from each of the end–use groups but instead remain mixed with others belonging to the same use–category.[13]

In preparation for sowing, the woman head of the household either gathers tubers from storage or plants the entire remaining stock. She chooses few tubers individually but instead separates a portion of the remaining tubers, which typically contains a more or less representative mixture of previously planted cultivars. Despite being able to identify upwards of 40 cultivar types, most women seed selectors purposefully ensure the planting of only a handful of favorite cultivars, usually for either their production or consumption qualities. Within the "boiling potato" use–category, most agriculturalists prefer three cultivars (***qompis, suyt'u,*** and ***olones***) as good producers. The best–tasting of "boiling potato" cultivars comprise a separate group, including the cultivars ***ch'uruspina, choqllos,*** and ***runtu.***

Field composition.—Using a modified point intercept method (Barbour *et al.* 1980: 173), 225 plants were sampled in each of 26 fields containing the "boiling potato" (***wayk'u papa***) use–category. Sampled fields were located in each study area except the lower–valley site centered on Waqanqa (Fig. 1). The cultivar identification of tubers was made by the author, an assistant, and the field owner on the basis of morphological characteristics and local names, two independent sets of criteria that can be used to identify native crop cultivars in general and potato

FIG. 2.—Agriculturalist in highland Paucartambo culling "third-class" potatoes at harvest.

cultivars in particular (Brush *et al.* 1981, Harlan 1975b; see also the discussion under *Classification* above). Sampling results indicated a mean of 21.1 cultivars per 225 plants. In addition to demonstrating the high degree of diversity, findings reveal a remarkable uniformity of cultivar variation within polycultivar fields. The sample's low standard deviation (5.1) indicates a pronounced evenness of diversity levels among parcels. Concerning spatial patterning cultivars within most "boiling potato" fields are distributed randomly, a pattern referred to locally as ***charqhosqa.*** Block-type patterning of cultivars (***taka-takasqa***) is limited to fields in high-elevation, eco-territorially "extended" peasant communities.[14]

The second measure of diversity examined character differences among tubers in the sample. The 79 cultivars identified during sampling were distinguished on the basis of several character differences including tuber shape, eye pattern, and flesh color (Zimmerer 1988). Nearly half of 179 sub-cultivars, on the other hand, differed only in tuber skin color. Several groups of closely related sub-cultivars could be distinguished solely by this trait. Many sub-cultivar groups were found to contain parallel series of colors. Red-black and white-yellow-black particularly differentiated sub-cultivar pairs or triplets, respectively. Sampling showed that fields containing one member of a sub-cultivar series were likely to include the other members ($p < .05$).

Selection of cultivars.—Limited support for ecological rationales in the selection of potato cultivars for planting *within* the field is offered by the above findings on agricultural practices, objectives, and field composition. The agriculturalists of

highland Paucartambo organize the composition of fields primarily according to use–category rather than individual cultivar. As a result of the taxonomic composition specified by each use–category, potato species are confined to a well-defined range of agroecological habitats (via the contrasting ecological parameters of different production zones). The choice of cultivars within single fields, however, does not involve a similar level of culinary or agroecological specification. Agriculturalists specifically select only a few cultivars for these purposes. Directed selection related to divergent production and consumption preferences accounts for only as many as eight or so of the roughly 21 cultivars that typically occur in "boiling potato" fields.

The absence of cultivar–by–cultivar management in "boiling potato" fields also was revealed by an interview completed with owners following the sampling of their fields. It showed that those "boiling potato" cultivars gauged to be most favorable were consistently among the least common. The similar lack of correspondence between preference and frequency in potato fields in a nearby region of the Southern Peruvian Andes surprised Jackson and his colleagues (1980:113) who found that "three varieties classed as poor were grown at a higher frequency than some of those which were considered good or intermediate." This evidence further argues against the role of directed selection in polycultivar fields. Combined with other findings, it reveals that selection for ecological objectives is not an adequate explanation of how and why agriculturalists in highland Paucartambo maintain diverse potato cultivars.

Agricultural practices and cultivar composition of "boiling potato" fields support a model of selection based on perceptual distinctiveness. As Boster (1985:324) suggests, Andean potato agriculture shows characteristics (e.g., polycultivar plantings, vegetative propagation) that favor the targeting of perceptual differences in seed selection. Moreover, if tuber skin color is posited as the perceptual focus of selection efforts, the potato crop meets the following preconditions proposed by Boster (1985:313): (1) variation of the trait must exist in the gene pool; (2) the character must be perceptually salient to the cultivator; and (3) the character cannot interfere with the utility of the cultivar.[15]

Both biological and ethnographic findings of research in highland Paucartambo support selection for skin–color distinctiveness as a major guide in maintaining taxonomic diversity within polycultivar potato fields. Biologically, the selection of distinct color types is evinced by the high frequency of related sub–cultivars within single fields that differ only in the hue of the tuber's skin. Moreover, uniform levels of cultivar diversity in "boiling potato" fields (standard deviation = 5.1; see the discussion under *Field composition*) suggests that agriculturalists share culturally constructed perceptions of distinctness among cultivars. The removal of a sub–sample of stored tubers rather than the selection of individual specimens permits agriculturalists to contrast cultivars with one another, even if based only on the overall impression of diversity.

Three additional features of polycultivar potato fields need to be underscored. First, the biological manifestation of selection for perceptual distinctiveness is shaped by economic and social contexts, namely the organization of fields according to use–categories. Secondly, results of experimental and field studies have

demonstrated the non-specialized adaptation of most conspecific potato taxa to climatic environments, thus suggesting that directed selection (intra-specifically) for agroecological purposes might offer little advantage (Zimmerer 1990). Thirdly, as in Boster's original formulation, selection for perceptual distinctiveness only accounts for how agriculturalists choose diverse cultivars but not why they do so. Before examining this latter question in the concluding section, the planting of diverse maize cultivars in the Paucartambo highlands is examined.

MAIZE

Context.—The agricultural complexity of maintaining diverse maize cultivars rivals potato production and offers several counterpoints including ecology, areal extent, and religious importance (see Mayer 1985, Murra 1960, Yamamoto 1985). In highland Paucartambo, maize cultivation comprises one of the major forms of land use in the production zone of the inner canyons below 3500 m (***kheshuar***). Although the majority of households in the region cultivate only one or two maize fields, the crop is widely esteemed as both a dietary item and an element of ritual and ceremonial practice.[16] Unlike potatoes, maize is exchanged frequently, and even annually, especially among peasant farmers in marginal growing environments of the upper valleys (3100–3500 m).

Maize is organized into three "field plantings," each matched to a distinct calendar, elevational range, and intra-specific groups of cultivars belonging to separate taxonomic races (Table 4). The "late planting," for instance, consists of maize types with a short growing season suited to late planting and early

TABLE 4.—*Maize "Field Plantings" in Highland Paucartambo.*

"Field Planting" (Local name)	Calendar (Planting–Harvest)	Elevational Limits (meters)	Major Races	Major Uses
"Early Planting" (***hatun muhu***; "large seed")	Sept 15–June 15	2700-2800	Huancavelicano	boiling
			Ancashino	boiling
			Paro	boiling
			Uchuquilla	boiling
"Middle Planting" (***chaupi muhu***; "middle seed")	Oct 15–May 15	2800-3300	Piscoruntu	parching
			Kulli	beer-making
			Confite Puntiagudo	popcorn
"Late Planting" (***uch'uy muhu***; "small seed")	Nov 15–May 1	2800-3500	Cusco Cristalino Amarillo	boiling
			Cusco	boiling
			Morocho	boiling

harvest. It occupies the uppermost elevations of maize production.[17] Differences in the diversity and number of plantings per household depend largely on the availability of suitable environments. A striking contrast distinguishes the humid lower Mapacho valley (e.g., Waqanqa, see Fig. 1), where agriculturalists produce each of the three types of "field plantings," from the semi-arid upper valley (e.g., Mollomarca and Colquepata), where many of their counterparts rely on a single planting regime.

Maize types for boiling and parching, two distinct use-categories, are paired loosely with different "field plantings" and their associated labor calendars and agricultural habitats (Table 4). Cultivars used for boiling (referred to collectively as ***mut'i sara***) mostly comprise the "early planting" and "late planting" and only a small fraction of the "middle planting," the majority of which is made up of parching cultivars (***hank'a sara***). Although some "middle planting" cultivars such as those belonging to the race Pisccorunto actually mature in less time than "late planting" cultivars (see Grobman *et al.* 1961:356), the former are grown for a longer period to ensure complete maturation and thereby guarantee a floury endosperm suitable for parching. The prominence of two use-categories for maize in highland Paucartambo (one for boiling and one for parching), as well as the racial affinities of their cultivar constituents, appears to resemble agriculture in other Central Andean regions (Bird 1971, Gade 1975).

Cultivars intended for parching and boiling are also employed in a wide variety of secondary preparations in the study region. As a result, single fields contain cultivars intended for several dishes. Less common yet nonetheless important uses include beer (***aqha,*** Sp. ***chicha***), hominy (***fata***), crushed maize (***chaqhe***), popcorn (***mana***), mush (***api***), corn-on-the-cob (***choqllo***), soup thickener (***lawa***), pudding (***mazamorra***), and tamale (***tamales, huminta***). (The array of local culinary preparations encompasses most of those recorded for the Peruvian Andes [Bird 1971, Gade 1975, Grobman *et al.* 1961]). Except for popcorn, which requires a single type, secondary uses are not matched exclusively to certain cultivars. Several cultivars employed in secondary preparations are in fact grouped according to their use as boiling types (***mut'i sara***).

Classification, naming, and selection.—The structure of maize classification in highland Paucartambo closely approximates that of potatoes. Crop (Q. ***sara,*** Sp. ***maiz***), use-category (e.g., ***mut'i sara, hank'a sara***), cultivar, and sub-cultivar form the major taxonomic categories (Table 5).[18] Like potato classification in the study region, taxonomic groups tend to represent biologically significant categories. The maize types prepared by boiling (***mut'i sara***), for instance, consist mainly of cultivars that belong to the races Cusco Cristalino Amarillo, Cusco, and Morocho (Grobman *et al.* 1961). Cultivars belonging to the use-category designated for parching (***hank'a sara***), on the other hand, are derived primarily from the race Pisccoruntu. Yet, as shown below, the resemblance of classification as well as naming in the maize and potato crops does not correspond to similar systems of cultivar selection. The comparison of cognitive-linguistic practices in highland Paucartambo and those predicted by the proposed universal model offers a useful basis for showing the properties of cultivar management in the maize crop.

TABLE 5.—*Folk Taxonomic Classification of Maize in Highland Paucartambo.*

Crop	Use-Category	Cultivar	Sub-cultivar
	hank'a sara	***parakay***	***leche parakay***
			oqe parakay
			yuraq parakay
			puka saqsa
		saqsa	***yuraq saqsa***
			fallcha saqsa
sara	***mut'i sara***		
		k'ellu	
	aqha sara	***kulli***	

Maize classification in highland Paucartambo veers considerably from the universal model of folk taxonomy proposed by Berlin *et al.* (1973, 1974). Perhaps most notably, the local system does not evince inclusive relations between the use-category (folk species) and cultivar (folk variety) ranks. The non-exclusive associations of cultivars with use-categories reflect "heterarchical" rather than hierarchical forms of taxonomic organization. Cultivars classified as boiling types, for instance, periodically serve in other dishes as mentioned above. One of these, ***k'ellu sara***, is often classified as belonging to both the boiling and beer-making use-categories (Table 5). Maize classification also transgresses the rules of the proposed universal model by assigning primary lexemes to many would-be folk varieties (i.e., cultivars [see Table 5]). And, like the systems of classification and naming used for the local potato crop, those of maize extend to the level of folk sub-variety (sub-cultivar). The common usage of sub-variety labels for maize reveals the considerable precision characteristic of local crop naming.

Agricultural management of maize ears demonstrates a key link between the classification system, "field planting," and the cultivar composition of fields. This connection is due to the sharing of certain criteria by both the local and scientific systems of intra-specific classification. It is especially evident in identifying "field planting," for which cultivators draw on morphological markers that also are important in biological classification. In particular, the designation of most ears with hard flinty endosperm for either the "early planting" or "late planting" and those with a soft floury interior solely for the "middle planting" parallels the biological division of flint and flour corns, respectively, which in highland Paucartambo are represented primarily by cultivars belonging to the races Cusco Cristalino Amarillo and Pisccorunto. Local agriculturalists' organization of field composition by "field planting" and maturation therefore maintains a major evolutionary divergence within the maize crop of highland Paucartambo.

Maize naming by peasant farmers in the study region draws on many of the same symbols represented in potato nomenclature despite their contrasting growing environments and cultivation practices. Some cultivars, such as ***ruk'i,***

waqankilla and ***qompis***, receive the same labels as their potato counterparts. The names of many maize cultivars derive from features of the high-elevation grassland, including flowers (e.g., ***fallcha,*** a liliaceous herb), plants (e.g., ***saqsa***, a bromeliad), and animals (e.g., ***pisco*** [sparrow], ***urpi*** [dove], ***llut'u*** [quail]). In contrast, landscape features characteristic of the maize–growing zone are rarely utilized to label members of the crop. ***Ch'uspi*** (''flea''), which refers to a speckled parching maize, is the most notable representation of the maize environment in cultivar nomenclature. This finding counters the possible suggestion that agriculturalists necessarily derive referential cultivar names from the landscape that surrounds production. Although the names of some maize cultivars express social and cultural ties to the symbolically potent high–elevation landscape, this similarity does not imply that maize naming is identical to that of potatoes.

Maize naming does not evince nearly the symbolic richness present in potato nomenclature. Color terms, for instance, are much more conspicuous among cultivar names of the former (e.g., ***k'ellu sara*** [''yellow maize''], ***puka sara*** [''red maize''], ***oqe sara*** [''gray maize'']). In contrast, the labelling of cultivars based on color is notably absent from the nomenclature system created for native potatoes. (Note, however, that many sub–cultivars in the native potato crop are differentiated according to color.) The use of more color terms but fewer symbolic labels in maize naming than in that of potatoes might be due to the brighter palette in maize coloration and the greater cultural–historical legacy of potatoes among Andean peoples (Murra 1960).

Agriculturalists identify consistently all but the most morphologically ''mixed'' maize ears grown in their fields. Mixed ears (a condition referred to locally as ***amachayoq***) arise from hybridization and display morphotypes partially resembling those of two or more cultivars. To maintain the identity and ultimately the diversity of cultivars, agriculturalists must share criteria for disqualifying mixed types as potential seed sources. Elimination of strongly mixed ears is guaranteed by a commonly recognized array of indicators (number and orientation of rows, color and shape of kernels) and designations (e.g., ***saliasqa, cholosqa***) that are used to distinguish extremely variable off–types.

The selection and storage of maize involves the designation of ears belonging to individual cultivars from within use–category groups. This highly specific form of management begins prior to storage. After husking, ears are carried to the ''drying floor'' (***tendal***) where they are separated according to cultivar type (Fig. 3). Dried ears are then stored, an activity undertaken almost exclusively by women heads of household. Women also select seed ears from the array of separately stored types. When selecting seed ears for future use, they choose individual specimens, setting them aside in order to shell by hand shortly before planting.[19] (Only kernels from the ear's middle section are selected due to their uniform development and better see viability.) The direct selection of maize cultivars for inclusion in polycultivar fields, evident in the designation of ears to provide seed, sharply contrasts the group–type selection used to choose the majority of potato cultivars.

By considering diverse criteria to specify individual maize cultivars within a use–category, agriculturalists assure the maintenance of more than one type

FIG. 3.—Harvested ears of boiling and parching maize separated by cultivar type on the "drying floor" (highland Paucartambo).

in nearly all subsistence fields. Two practices in particular indicate rationales for the polycultivar composition of maize fields. First, many cultivars preferred consumption differ from those possessing esteemed production traits within the same use–category. ***Chullpi***, for instance, is widely thought to be the best–tasting cultivar among the parching (***hank'a***) types although others such as ***leche parakay*** are much preferred for their yield. Secondly, single maize fields sometimes include more than one "field planting." Different sections of the field are effectively managed as separate "field plantings." As a consequence of this practice, certain fields contain maize types for both parching and boiling, thereby including as many as four or five cultivars, each of which is designated for a specific production or consumption attribute.

Field composition.—The cultivar diversity of polycultivar maize fields is significantly less than that of potato parcels. Sampling of fields belonging to 36 households evenly divided among the four study regions (Fig. 1) revealed that maize fields contain a mean of 2.9 cultivars. The household's total stock of cultivars was found to vary according to the diversity of distinct "field plantings." Households in the upper Mapacho valley, where most agriculturalists produce the "middle planting" as well as the "late planting," cultivate a mean of roughly 6 cultivars. Lower valley households, on the other hand, typically maintain between nine and 10 cultivars.

Two spatial patterns of planting characterize maize fields. Most subsistence producers mix cultivar seed randomly within a single field, an agricultural prac-

tice shared by their counterparts in other Central Andean regions (Bird 1971, Gade 1975). The random planting of cultivars, referred to locally as ***michusqa***, is analogous to the mixtures commonly sown in nearby potato fields. Some agriculturalists in the lower Mapacho valley, on the other hand, plant maize cultivars in blocks (referred to as ***melga-melgantin***). The block arrangement permits separate sowing according to the maturation period of cultivars within the same "field planting." Popcorn, for instance, matures more slowly than other "late planting" cultivars and therefore is sown slightly earlier.

The visually impressive morphological diversity of ears produced in single polycultivar fields is promoted by the planting of cultivars in mixtures, a practice that assures high rates of sexual recombination. Taxonomic identification of the field sample, however, revealed that much morphological variation does not correspond to significant biological divisions. Although sample fields contained 11 of the 33 maize races found in highland Peru and a total of 27 cultivars identified on the basis of row length and number (Zimmerer 1988), the much larger number of sub–cultivars (117) reflects many identifications based solely on differences in kernel color. Unlike their counterparts in the potato crop, maize sub–cultivars do not show regular series of morphological variation within related groups.

Selection of cultivars.—Culinary and production rationales guide peasants' maintenance of diverse maize cultivars in highland Paucartambo. Directly selection of individual maize types differs substantially from the group–type selection of potatoes. Two scales of examination are required to explain how directed selection maintains the diversity of maize cultivars: polycultivar diversity within the field and overall diversity within the region. Although the regional diversity of maize cultivars is moderate (27), within–field variation involves few cultivar types (mean 2.9).

Directed selection of a few favored cultivars for production or culinary attributes suffices to explain the variation within polycultivar fields. Maintenance of maize diversity at the regional scale, on the other hand, is built on the system of staggered "field plantings." Temporally distinct calendars for maize production even out labor requirements and the supply of harvested products while also providing households with maize suited to various culinary uses. In effect, regional maize diversity is maintained mainly by the delimitation of growing season and "field planting" while within–field variation is dictated by the selection of preferred cultivars in the context of each "field planting." (It is noteworthy that the production schedules of other crops in the study region, such as potatoes [see Table 1] and ***lisas*** [*Ullucus tuberosus* Lozano; known in most of Peru as ***olluco***], reveal similar combinations of staggered agricultural calendars in association with diverse cultivar types.)

Little evidence from the classification, selection, and cultivar characteristics of maize agriculture in highland Paucartambo supports a model of seed selection based on perceptual distinctiveness. Furthermore, the pattern of variation in kernel characteristics among sub–cultivars would be unlikely to result from the selection of perceptually distinct morphotypes based on color. Rather than maintain

perceptually distinct types, seed selectors rely on kernel color to eliminate off-type coloration patterns. Thus, maize producers mainly select for different growing seasons among the cultivars found in separate "field plantings." Morphologically similar cultivars possessing markedly different growing seasons (e.g., the related sub-cultivars ***k'ellu sara uch'uy muhu, k'ellu sara chaupi muhu, k'ellu sara hatun muhu***) particularly evidence this mode of selection.

Reproductive biology and genetic architecture are central to understanding the maintenance of diversity in polycultivar maize fields. Repeated selection for perceptual distinctiveness in maize would create an unwieldy number of cultivars and sub-cultivars within no more than a few years. The majority of variants produced under such selection would display either agroecologically insignificant or unfavorable attributes. Even with an ample supply of labor—unlike the deficit condition of the region's present rural economy—highland Paucartambo agriculturalists would probably be unable to marshal the additional effort necessary to manage such a large cultivar pool.

CONCLUSIONS

Previous studies of polycultivar fields in non-industrial agriculture have dealt partially with three interconnected questions: (1) what is the nature of cultivar diversity both in terms of field composition and cultivar characteristics?; (2) how do agriculturalists maintain these stocks of diverse cultivars?; and (3) why do agriculturalists plant polycultivar fields? Explanatory models tend to focus on one or two of the above inquiries. Two contrasting explanations—selection for perceptual distinctiveness (Boster 1985) and directed selection for production and consumption objectives (e.g., Harlan 1975a)—were found to account only partly for the maintenance of diverse potato and maize cultivars in the highland Paucartambo region of Southern Peru.

Selection for perceptual distinctiveness complements direct selection as the key practices that Paucartambo agriculturalists use to manage polycultivar fields of "boiling potatoes." Such parcels show a high level of cultivar diversity (21.2 cultivars/225 fields) that is remarkably uniform (standard deviation = 5.1). Agriculturalists do not directly choose most potato cultivars individually but instead select stock for planting based on perceptions of overall variation. In contrast, maize ears are selected directly for both production and consumption characteristics, resulting in a much lower diversity per polycultivar field (2–4 cultivars/field). The twin explanations of potato and maize selection, however, do not account for crucial contextual parameters and cultural meanings that envelop the management of polycultivar fields and thus the maintenance of diverse cultivars.

Polycultivar potato and maize fields are integrated into peasant production by the organization of use-categories. Use-categories reflect divergent culinary, commercial, and household-economic objectives. They also are associated with differences in agricultural environments, calendars, and taxonomic groupings. (Potato use-categories correspond to one or more species or sub-species while each use-category of maize contains one or more sub-specific races.) Characteristic of separate polycultivar fields (or sometimes sections within fields), use-categories

structure the selection and maintenance of diverse cultivars. The close tie between the taxonomic specification provided by use–categories and the socio–economic context of peasant livelihood is of great practical and biological significance. Although the management of use–categories has not been highlighted previously, the prominence of certain "contextual categories" suggests the possibly widespread importance of this supra–cultivar level(s) of organization in poly-cultivar agriculture (e.g., Boster 1985:317).

The contrasting rationales for cultivar selection in potatoes and maize further divide the management practices distinguishing their cultivation in the Central Andes. In the subsistence maize crop, direct selection is carried out to meet preferences for production and consumption traits. The maintenance of most diverse potatoes through selection for perceptual distinctiveness, however, is clearly not motivated in the same way. Peasant farmers do not individually select the majority of potato cultivars. Indeed, the cultural significance of potato cultivars appears to be more general and symbolic than individual and ecological. The greater role of a symbolic logic in potato than in maize cultivation might stem from the much lengthier and richer legacy of the former in Andean prehistory (Murra 1960). It is reflected especially by cultivar naming, which draws heavily on images from the high–elevation grassland, the landscape source of abundant icons that local inhabitants spin into their webs of group identity.

Cultural meanings infusing diverse cultivars of potatoes as well as maize need to be counted among the reasons for the *in situ* conservation of crop diversity. Although recent research has focused attention on the urgent need to conserve native crop cultivars as biological resources (e.g., National Academy of Sciences 1972), and to maintain then *in situ* without hindering development or the loss of local control (Altieri and Merrick 1987, Brush 1989), the value of permitting continued development of symbolic landscapes has received little attention. The symbolism of diverse cultivars represent one aspect of "being Quechua" in contemporary highland life. In essence biological icons, native crops constitute important cultural resources for dominated Andean highlanders as they view themselves in relation to the non–Quechua and work towards constructing alternative and more just social relations.

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NOTES

[1]Present Address: Department of Geography, 384 Science Hall, 550 N. Park St., University of Wisconsin, Madison, WI 53706. This paper was submitted on January 3, 1990. It was accepted for publication on August 28, 1990.

[2]Although most "landscape" studies in human geography do not deal with the theme of peasant landscapes but rather address the construction of environments by dominant social groups, especially the built or architectural environment (see review by Meinig 1979), the perspective potentially integrates the material (agroecologic) and symbolic relations underpinning polycultivar agriculture.

[3]The present study does not focus on the "conditions of existence" that determine why diverse-cultivar systems of agriculture either persist or disappear. Although analysis of the "conditions of existence" enveloping polycultivar agriculture overlap with the question of field management, it mostly comprises the distinct theme of cultivar loss or so-called genetic erosion.

[4]Research in cultural and human ecology initially investigated polyspecific ("many-species") plantings but overlooked the prominence of polycultivar plantings until fairly recently (cf, Beckerman 1983, Hames 1983).

[5]The terms cultivar or land race refer to "variable, integrated, adapted populations" (Harlan 1975b: 618, also see Harlan and deWet 1971). The *International Code of Nomenclature of Cultivated Plants—1969* defines the term in the following way: "The international term *cultivar* denotes an assemblage of cultivated plants which is clearly distinguished by any characters (morphological, physiological, cytological, chemical, or others), and which, when reproduced (sexually or asexually), retains its distinguishing characters ... This term is derived from *culti*vated *var*iety, or their etymological equivalents in other languages" (Gilmour *et al.* 1969:12).

[6]The number of cultivated potato fields per household varies between one and 14 or more. Potato cultivation represents between one-half and two-thirds of annual agricultural production for most highland Paucartambo households.

[7]Mayer (1985) defines production zones as both land-use areas and as distinct agricultural systems.

[8]Tuber exchange has been found to be particularly important in determining regional distribution patterns of the cultivars as well as alleles of native potatoes (Zimmerer 1990, Zimmerer and Douches n.d.).

[9]Potato agriculture in the Central Peruvian highlands was found to contain the equivalent of three use-categories: bitter potatoes, native potatoes, and improved varieties (Brush *et al.* 1981:80).

[10]Other studies of native-potato agriculture in the Peruvian Andes reveal identical or similar categories (Brush 1980, Gade 1975, LaBarre 1947, Patron 1902).

[11]LaBarre (1947:85–86) also presaged the latter development of a formal folk taxonomic model, writing that "The Aymara potato taxonomy is based on the use of a descriptive word for the variety, with the addition of a modifying adjectival word (often a color-name) to distinguish sub-varieties."

[12]Paucartambo highlanders resemble other Andean agriculturalists (Brush *et al.* 1981:77, Gade 1975:205), in mainly using tuber characteristics to identify cultivars.

[13]The separate management of individual native potato cultivars within polycultivar fields is practiced by some agriculturalists residing in "extensive" (as opposed to "compact") communities that consist primarily of high-elevation grassland habitats. Although these potato growers manage several cultivars separately, at least half of their diverse stock is maintained in a fashion similar to that utilized by their counterparts occupying valley sites.

[14]Analogous patterns of intra-field cultivar diversity were noted by Brush and his colleagues (1981) in the highlands of Central Peru. Although oral histories collected in Paucartambo suggest that random plantings might represent the historic simplification of more time-consuming block arrangements, this evidence remains incomplete. As underscored by Hame's (1983:19) critique of previous assumptions that commercialization caused the ecological simplification of intercropping along the Venezuelan Orinoco, the reasoning of agricultural change requires historical substantiation.

[15]Tuber skin color could interfere with utility by undermining storage capacity. Light-skin tubers are more liable to begin photosynthesis in skin tissue and subsequently generate distasteful, and toxic, alkaloids (Brush *et al.* 1981:83). Paucartambo cultivators, however, do not weigh this criterion when choosing potatoes.

[16]Murra (1960) shows that the prestige attributed to maize by Central Andean people originated in the expansion and promotion of the crop by the Inca state. Maize production in highland Paucartambo is less commercialized than potatoes although specialty production of a cultivar bought by Cusco beer (***chicha***) manufacturers characterizes its economy in certain areas of the region.

[17]Each planting is named according to seed size, reflecting a loose-knit correspondence between seed size and the maturation period of maize cultivars. Hence, the early planting, which requires the longest to mature, is referred to as ***hatun muhu*** ("big seed"). The terms ***chaupi muhu*** and ***uch'uy muhu*** ("middle seed" and "small seed") are attached to the middle and early plantings, respectively.

[18]Each of these four groups also is used in the identification of maize in other Central Andean regions, such as the neighboring Vilcanota Valley (Gade 1975:112–119) and the highlands of Central Peru (Bird 1971:113).

[19]The great effort evident in separating and selecting maize seed highlights the considerable labor required for Quechua peasant cultivators, like smallholder agriculturalists of other Amerind ethnic groups (see, for example, Wellhausen *et al.* 1957 on Central America), to maintain diverse cultivars.

[20]Cultivators refer to the slightly advanced planting of the popcorn cultivar ***(perlas)*** as an "early planting" (***nawpaq tarpuy***) within the late crop. They sow this cultivar on infertile soils (locally ***q'ara hallpa***). This is the sole case of microenvironmental siting in the management of the Paucartambo maize crop.

BOOK REVIEW

Thompson Ethnobotany: Knowledge and Usage of Plants by the Thompson Indians of British Columbia. Nancy J. Turner, Laurence C. Thompson, M. Terry Thompson, and Annie Z. York. 1990. Memoir No. 3, Royal British Columbia Museum, Victoria, B.C., Canada. 335 pp., illustrations, five appendices, index. $15.00 Canadian.

Thompson Ethnobotany is perhaps the most comprehensive ethnobotanical ethnography for native North America and the most detailed account of the ethnobotanical knowledge of any non–agricultural people. It is the result of a collaboration of more than 20 years among the authors, Nancy Turner, a botanist of outstanding anthropological sensitivity, Laurence and Terry Thompson, leading Salishan linguists, and Annie York, born in 1904, a native speaker of Thompson Salish, and a life–long resident of the Thompson homeland. To this winning combination must be added an additional collaborator, James Teit (mentored by Franz Boas), whose pioneering Thompson ethnobotanical research (conducted 1896–1918), enhance the time depth of this study by a full 90 years. It is significant to note, however, that only some 20 species are no longer recognized by contemporary elders.

The core of this book is the "Inventory of Plants Species Named and/or Used by the Thompsons," 224 pages annotating (and often illustrating with clear black and white photos) nearly 400 species of plants. These entries are listed alphabetically by scientific name within each major grouping, from algae and fungi through the flowering plants. Each entry includes Latin species and genus name, authority (with major synonyms), then a list of Thompson Salish Terms recorded for that species, with the initials of specific informants noted. Terms are interpreted linguistically and compared to other published versions of the native names. An encyclopedic summary of ethnobiological data follows. While a few entries—mostly for introduced plants—are brief (even plants that are not named are noted if they were recognized), other entries run to several pages, as for western red cedar, Douglas fir, yellow–avalanche lily, serviceberry, and Indian hemp.

The cultural significance of plants is broadly conceived, but organized in standard fashion under such headings as foods (120+ species), materials (115+ species) and medicines (200+ species). Species used as food are subgrouped as

"roots;" green vegetables; fruits, nuts, and seeds; "innerbark;" mushrooms, and fungi; canned or emergency food; beverages; chews; and flavorings and confections. The large number of plant species used as food belies the biased view of Pacific Northwest economies as essentially based on the fisheries. However, the authors do not attempt to estimate the relative nutritional contribution of various categories of food to traditional Thompson diets. The cultural role of plant foods is further clarified by summaries of methods of harvest, preservation, cooking and serving, with consideration of their contemporary role. The harvest and preparation plants used for wooden implements, for fuel, for their fibers and bark, for "dyes, stains, paints, and preservative," for resin or pitch, and as scents and/or cleaning agents are also summarized. Medicinal plants are grouped according to general categories of illness for which they are employed. Mode of application and dosage are carefully noted whenever possible and appropriate cautions are offered when potentially harmful plants are involved. Ecological and mythological associations are systematically noted. In sum, Turner *et al.* have left no stone unturned.

Turner's longstanding interest in contributing to the comparative analysis of universals of classification and nomenclature as proposed by Brent Berlin is well known to readers of this journal. However, the results of Turner's meticulous analyses of the folk botanical classification systems of Thompson and neighboring languages are only briefly summarized here, as they have been published elsewhere.

Thompson Ethnobotany is a model for the conduct of ethnobotanical ethnography among what, for want to a better term, we might call "heavily colonized" indigenous peoples, i.e., those whose aboriginal ecological adaptations have been so radically altered by the course of colonial history that the memories of living elders are a precious and fragile resource. Turner, Thompson, Thompson and York have saved here an impressive fragment of Thompson Indian traditional environmental understanding for the edification of future generations.

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INTERACTION BETWEEN ISLAND FOXES (*UROCYON LITTORALIS*) AND INDIANS ON ISLANDS OFF THE COAST OF SOUTHERN CALIFORNIA: I. MORPHOLOGIC AND ARCHAEOLOGICAL EVIDENCE OF HUMAN ASSISTED DISPERSAL

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ABSTRACT.—The island fox, *Urocyon littoralis,* occurs on six widely separated islands off the coast of Southern California. Using cranial morphometrics, present day samples from each of the six island populations and archaeological samples from four of the islands were examined for patterns of geographic variation. Univariate and multivariate statistics were used to clarify evolutionary relationships. Morphometric analyses revealed that morphological divergence in the Northern Channel Island populations is consistent with their spatial distribution and known geological history, whereas the Southern Channel Island populations showed no such concordance. Phenetic affinities of archaeologically obtained island fox material, together with occurrence of island fox bone material only in Middle to Late Period sites on the Southern Channel Islands suggests that Indians were probably responsible for establishing foxes on San Clemente, Santa Catalina and San Nicolas Islands.

Data in the archaeological record were used to determine when Indians would have dispersed island foxes. Examination of the fox remains in Channel Island archaeological sites revealed that foxes were present on the Northern Channel Islands prior to the arrival of Indians 9,000–10,000 years ago. On the Southern Channel Islands foxes do not appear in the archaeological record until about 3,400–3,800 years ago on Santa Catalina and San Clemente Islands and 2,200 years ago on San Nicolas Island. Results of morphometric and archaeological analyses both support a fairly recent, post–Holocene introduction of foxes from the Northern Channel Islands to the Southern Channel Islands by Indians.

RESUMEN.—El zorro isleño, *Urocyon littoralis,* se encuentra distribuido en seis islas ampliamente separadas fuera de la costa del sur de California. Por medio del análisis de la morfometría cranial de especimenes actuales de cada una de las seis poblaciones isleñas, y también de ejemplares arqueológicos de cuatro de estas islas, se determinaron configuraciones de variación geográfica. Se realizaron estadísticas univariadas y multivariadas para clarificar las relaciones evolucionarias. Los análisis morfométricos han revelado que la divergencia morfológica en las poblaciones de las islas del canal del norte es consistente con su distribución espacial e historia geológica ya conocida, mientras que las poblaciones de las islas del canal del sur no demostraron tal concordancia. Afinidades fenéticas de materiales de zorros isleños obtenidos por métodos arqueológicos, junto con la ocurrencia de materiales osteológicos de esto zorros, encontrados solamente en

sitios de a mediados hasta fines del período arqueológico en las islas del canal sur, sugieren que probablemente los indios fueron responsables de establecer a los zorros en las islas de San Clemente, Santa Catalina, y San Nicolas.

Información obenido del récord arqueológico utilizado para determinar cuando los indios dispersaran a los zorros isleños. La examinación de los restos de zorros en sitios arqueológicos de las islas canales reveló que los zorros se encontraban presente en las islas del canal norte antes de la llegada de los indios hace 9,000–10,000 años. Los zorros no aparecen en la historia arqueológica de las islas canales del sur hasta hace alrededor de 3,400–3,800 años en las islas de Santa Catalina y San Clemente y hasta hace 2,200 años en la isla de San Nicolas. Los resultados de los análisis morfométricos tanto como los análisis arqueológicos apoyan la teoría que una introducción bastante reciente de los zorros, después del período Holocénico, fue llevada a cabo por los indios desde las islas canales del norte hacia las islas canales del sur.

RESUME.—Le renard insulaire, *Urocyon littoralis,* se trouve dans six îles bien séparés loin du côte du sur de la Californie. On a examiné avec des morphométriques craniaux des échantillons actuels de chacune de six îles et aussi des échantillons archéologiques de quatres îles pour des modèles de la variation géographique. On a utilisé des statistiques univariates et multivariates pour clarifiquer des parentés évolutionaires. Les analyses morphométriques ont révélés que la divergence morphologique dans les populations des Iles du Canal du Nord est d'accord avec sa distribution spatialle et son histoire géologique connue, tandis que les populations des Iles du Canal du Sud n'ont pas montré une concordance semblable. Les affinités phénétiques des échantillons archéologiques du renard insuaire, ensemble avec l'occurence des échantillons des os du renard insulaire seulement dans les sites des Periodes Moyenne et Tarde dans les Iles du Canal du Sur, suggèrent que les Natifs ont probablement establissé le renard dans les Iles San Clemente, Santa Catalina, et San Nicolas.

On a utilisé l'information archéologique pour determiner l'année quand les Natifs auront dispersé le nenard insulaire. L'examination des restes du renard dans les sites archéologiques des Iles du Canal a révélé que le renard s'est trouvé dans les Iles du Canal du Nord avant de l'arrivée des Natifs il y a 9000–10,000 années. Le renard paraît pour la première fois dans le registre archéologique il y a 3400–3800 années dans l'Ile Santa Catalina et il y a 2200 années dans l'Ile San Nicolas. Les resultats des analyses morphométriques et archéologiques soustainne l'idée que les Natifs l'ont introduit recemment, après du Holocène, des Iles du Canal du Nord jusqu'aux Iles du Canal du Sud.

INTRODUCTION

Humans have played a significant role in directly or indirectly spreading animals into many new areas. Prehistoric peoples have had an especially profound effect on the zoogeography of many islands via transport and introduction of semidomesticates (e.g. canids, felids, suids, mustelids, viverrids), domesticates (e.g. equids, bovids, camelids), and commensals (e.g. canids, rodents). Early humans are known to have carried many animals in their watercraft (Wallace 1869; Darlington 1957; Carlquist 1965). Polynesians introduced dogs, pigs, and rats to islands throughout the Pacific, which in turn contributed to the extinction of many

endemic land vertebrates on these islands (Olson and James 1982a; 1982b; 1984). Olson (1982) believes that Indians were responsible for the introduction of the extinct rodent *Isolobodon portoriensis* to Puerto Rico and the Virgin Islands. The Haida Indians may have been responsible for the occurrence of deer mice (*Peromyscus maniculatus*) on many of the Queen Charlotte Islands off the coast of British Columbia (Foster 1963; 1965).

Considering their seafaring abilities and trading activities, it is not at all surprising that maritime Chumash and Gabrielino Indians, who occupied the California Channel Islands and adjacent mainland coast, were capable of transporting animals to some of the offshore islands (King 1971; Tartaglia 1976; Hudson *et al.* 1978). It is definitely known that they transported dogs in plank canoes (Schumacher 1877; Bowers 1890; McKusick and Warren 1959; Orr 1968). Native Americans may also have been responsible for intentionally or inadvertently introducing several species of terrestrial vertebrates from the mainland to islands off the coast of Southern California (Wenner and Johnson 1980; Johnson 1983), or for moving species between islands (Gill 1980; Wenner and Johnson 1980; Collins 1982; Johnson 1983). Indian transport in canoes has been used to explain patterns of variation observed in Channel Island populations of deer mice (Gill 1980; Ashley and Wills 1987; 1989), western harvest mice (*Reithrodontomys megalotis*) (Ashley 1989; Collins and George 1990), and island fox (Collins 1982).

The island fox (*Urocyon littoralis*) which is found on the six largest islands off the Southern California coast (i.e., San Miguel, Santa Rosa, Santa Cruz, San Nicolas, Santa Catalina, and San Clemente Islands; Fig. 1), is a diminutive form of the mainland gray fox (*U. cinereoargenteus*) (Grinnell *et al.* 1937). Fritzwell and Haroldson (1982) and Hall (1981) have given subspecific recognition (i.e., *littoralis, santarosae, santacruzae, dickeyi, catalinae,* and *clementae*) to fox populations on each island. Superficially there is little morphological variability among populations but the species is markedly different from the gray fox (Grinnell *et al.* 1937).

The distribution of island foxes has elicited considerable debate over how such a poor over-water disperser could colonize six widely separated islands (Wenner and Johnson 1980; see review in Collins 1982). One hypothesis suggests that present-day populations represent a relict form of a previously widespread, smaller, continental race which reached exposed offshore landmasses via landbridges resulting from eustatic sea level changes during the Pleistocene (Stock 1943; von Bloeker 1967; Remington 1971). A second, more widely accepted hypothesis states that original colonizing foxes were similar in size to those on the adjacent mainland, but unique selective pressures on the islands led to a reduction in size (Grinnell *et al.* 1937; Vedder and Norris 1963; Case 1978; Johnson 1978; 1983; Wenner and Johnson 1980; Collins 1982). Accordingly, gray foxes probably reached one of the Northern Channel Islands through chance by rafting or swimming (Wenner and Johnson 1980) and during an initial period of isolation evolved to their present small body size. Eustatic sea level change during the late Pleistocene could have permitted subsequent dispersal, via interisland landbridges, of small-sized island foxes across the Northern Channel Island chain (i.e., San Miguel, Santa Rosa and Santa Cruz Islands). Following arrival of Native Americans, this hypothesis concludes, island foxes were then transported to the

three largest Southern Channel Islands in Indian watercraft (Norris 1951; Vedder and Norris 1963; Johnson 1972; 1983; Wenner and Johnson 1980; Collins 1982; in press).

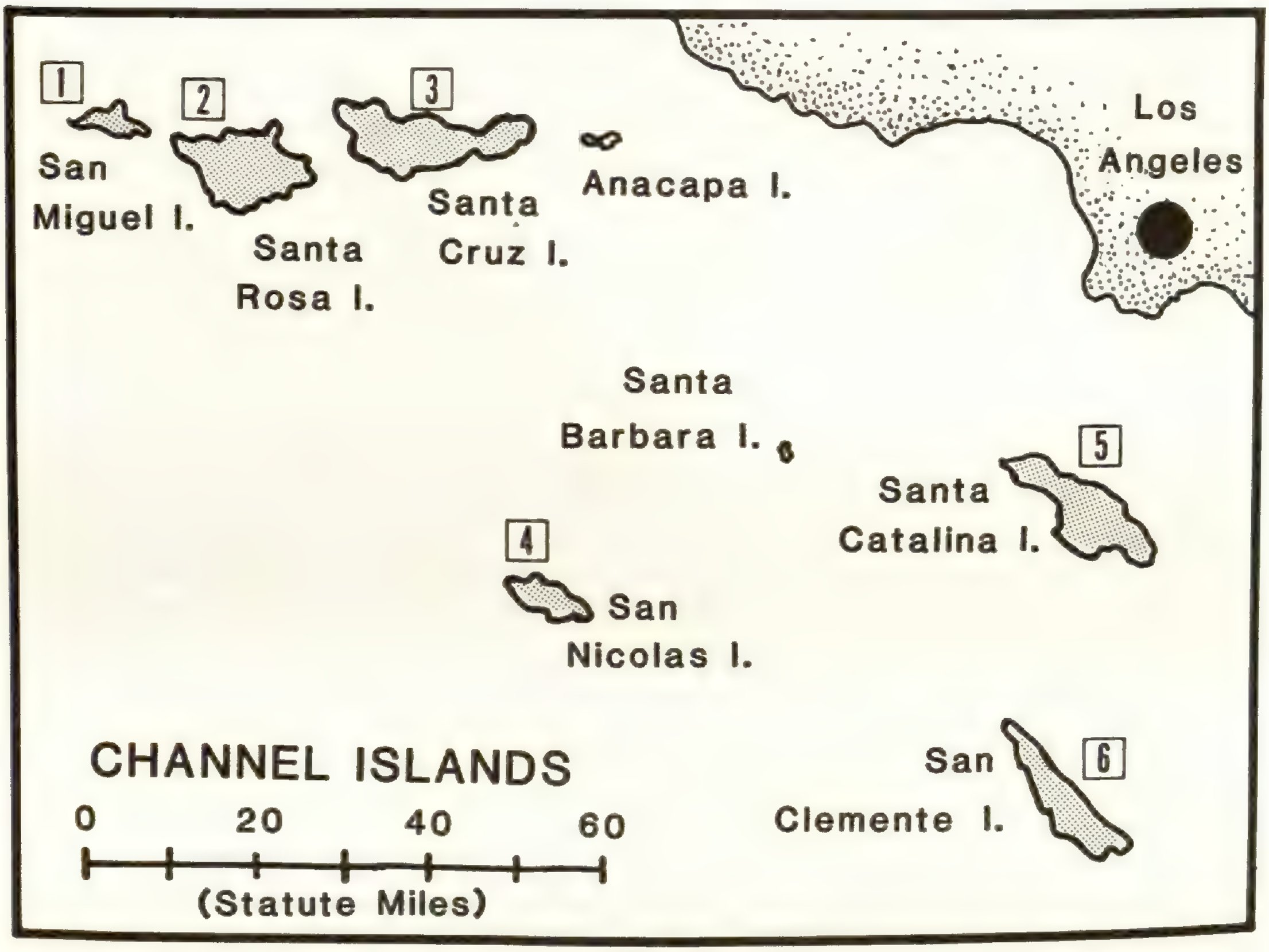

FIG. 1.—Map showing present-day sample localities. Numbers refer to the following samples: 1—SMI; 2—SRI; 3—SCrI; 4—SNI; 5—SCaI; 6—SCII. Acronyms are defined in Table 1.

If Native Americans were responsible for transporting foxes to some of the Southern California islands, then evidence to support this hypothesis should be present in phenetic similarities between present-day populations and archaeological samples. Examination of faunal remains recovered from Channel Island archaeological sites should: (1) provide evidence about whether island foxes were present on each of the islands throughout the period of human occupation, 9,000-10,000 years B.P.; (2) determine whether any fox populations were established as a result of Indian transport; and (3) determine the approximate time when foxes were first introduced to some islands.

The primary objectives of this paper are to: (1) clarify evolutionary relationships of island fox populations by examining morphological variability within and among present-day and archaeological samples; (2) document the role that Native Americans played in introducing island foxes to some islands on which they presently occur; and (3) based on the occurrence of fox remains in Channel Island

archaeological sites, determine sequence and timing for establishment of foxes on each island.

MATERIALS AND METHODS

Morphometric Analysis.—To examine interisland phenetic affinities of present-day and prehistoric island fox populations, I recorded twenty-nine measurements (Fig. 2; described in Collins 1982) from 497 present-day and 96 archaeologically recovered island fox skulls. All measurements were taken with dial calipers accurate to 0.01 mm. Before investigating patterns of geographic variation, I examined the extent of nongeographic, intraspecific variation from factors such as sexual, ontogenetic, and intra-locality character variation. Only present-day specimens were used in the analysis of nongeographic variation. To look at variation within and between populations, specimens were assigned to six *a priori* designated population samples (Fig. 1).

Univariate statistics (mean, standard deviation, standard error, and coefficient of variation) were calculated for each sample and all characters using PROC MEANS (Helwig and Council 1979). See Collins (1982:215-227) for a summary of these statistics. To give all variables more equal weight (regardless of their magnitude) and to make their variances more homogeneous across locality samples, I transformed all linear measurements to logarithms ($\log_e$). All further statistical procedures were performed on the transformed data.

Secondary sexual dimorphism was assessed for each of the 29 cranial measurements from one island sample (Santa Cruz Island), using *t*-tests (BMDP3D; Dixon 1983). Significant differences between the sexes ($P \leq 0.01$) were recorded for 27 of the 29 variables; therefore the remainder of the statistical analyses were run separately for each sex.

Ontogenetic variation was examined using a sample composed of all present-day island foxes. I assigned specimens to one of six age categories based on a combination of cranial suture closures, tooth eruptions, and molar tooth wear patterns described for the gray fox (Wood 1958). See Collins (1982: 141 and 169) for a diagram of molar wear patterns and a description of the characters used to distinguish each age category. Because of small sample sizes in the youngest and oldest age categories, the original six age classes were reduced to four: (1) juvenile (original age category 1-2); (2) subadult (age 3); (3) adult (original age category 4); (4) old adult (original age category 5-6). A one-way analysis of variance (F test) and Duncan's multiple range test were used to determine significant differences among means and maximal nonsignificant subsets (SAS; Helwig and Council 1979). As a result, specimens in age categories 2-4 were pooled for subsequent statistical analyses while specimens in age category 1 were excluded from further treatment. These results tend to agree with Wood's (1958) demarcation of adults in gray foxes.

Since only a few of the archaeological specimens possessed both skulls and lower mandibles, I only used 22 cranial characters (Fig. 2) for further statistical analyses. To use archaeological specimens in any further analyses, it was necessary to determine the sex of each specimen. To do this I ran a separate canonical variates

analysis (CVA) for each island sample. Archaeological specimens from an island were entered into a CVA analysis for that island as unidentified. These specimens were then evaluated with the discriminant equation generated from the reference sample to determine their sex. If the probability of classification to a particular

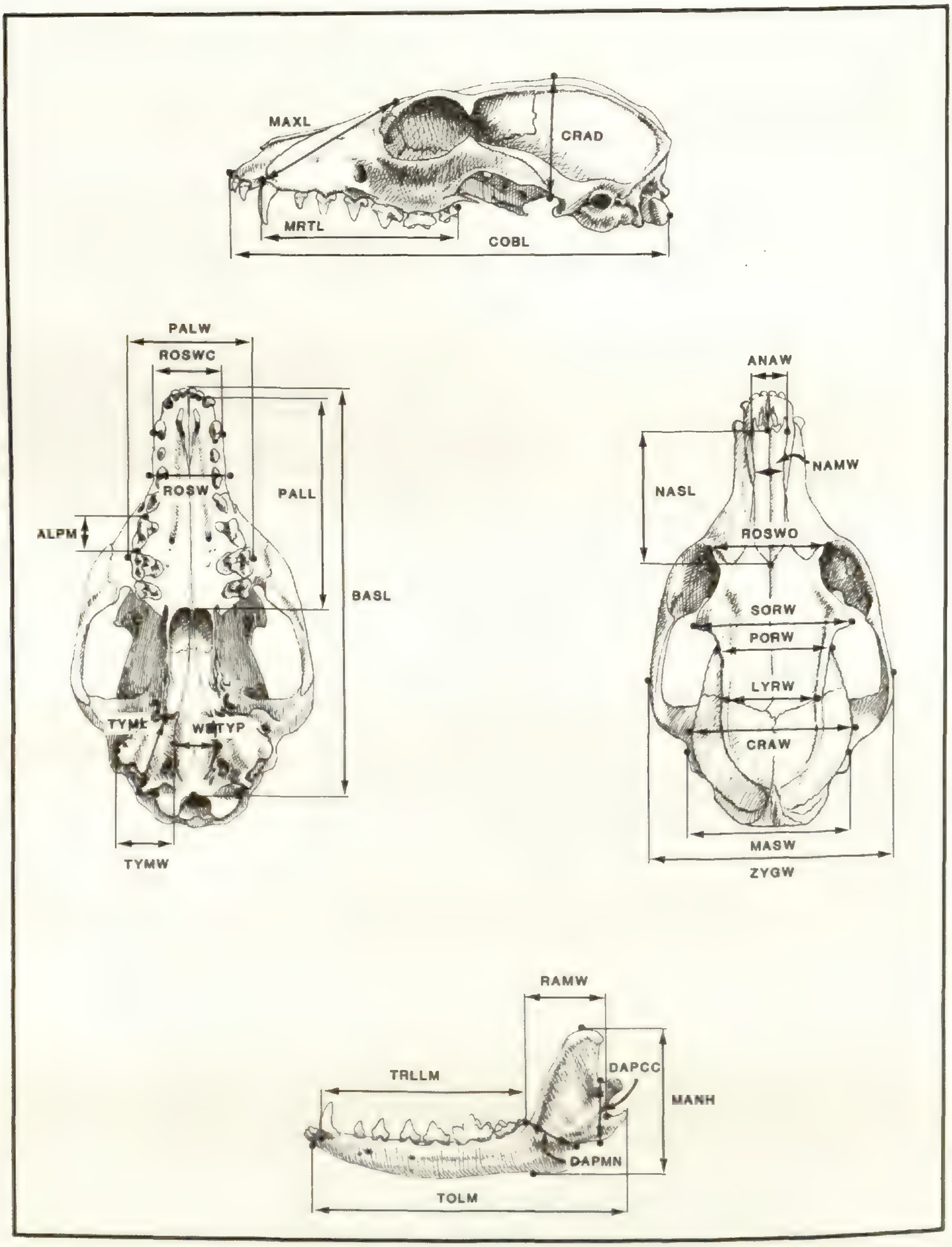

FIG. 2.—Twenty-nine cranial measurements used in this study; acronyms are defined and measurements are described in Collins (1982).

sex was 90% or above, then I assigned the specimen to that sex and included it in further multivariate analyses; otherwise it was removed from all further analyses.

Multivariate analysis of variance (MANOVA; Helwig and Council 1979) was used to determine if significant morphometric variation existed among *a priori* designated present-day samples. I assessed morphologic divergence and phenetic overlap among present-day and historic island fox populations using multigroup discriminant function analysis (BMDP7M; Dixon 1983). I analyzed males and females separately, using present-day fox samples as targets for classification of archaeological material. A set of canonical discriminant functions were calculated for each CVA and the centroid for each sample was plotted on the first two vectors. Minimum polygons enclosing all individuals in each population sample were drawn to illustrate the degree of phenetic overlap in present-day fox populations, and to clarify phenetic affinities of the archaeological specimens.

Archaeological Analysis.—I examined faunal material recovered from Channel Island archaeological sites for the occurrence of island fox bone and recorded type and quantity of fox bone found at each site, and when present, noted the provenience of each occurrence. In addition, I examined each bone for evidence of possible cultural modifications such as butchering, burning, unusual breakage and/or manufacturing marks, to determine whether a bone was derived from cultural or natural depositional processes. Intact skulls were measured and used in canonical variates analyses to clarify phenetic affinities between present-day and prehistoric fox populations.

RESULTS

Results-Morphologic Variation.—F-tests for both male and female samples detected statistically significant ($P \leq 0.05$) differences among the six present-day and four archaeological samples (Table 1), thus invalidating the null hypothesis of no statistically significant geographic variation among populations. While all of the F-tests for present-day samples were significant ($P \leq 0.0001$), some of the comparisions between present-day and archaeological samples were either insignificant ($P > 0.05$) or were at higher probability values (Table 1). Small size of archaeological samples probably contributed to higher P values obtained from comparisons with present-day samples (Table 1). Multivariate analysis of variance (MANOVA) disclosed that statistically significant differences (F transformation of Wilk's lambda statistic = 27.87; d.f. = 145, 1793, $P < 0.001$) exist among samples. Based upon the F-test and MANOVA results, I concluded that it was appropriate to investigate dispersion of these samples within discriminant space.

Mean centroids for each of six present-day and three to four archaeological male and female island fox samples are plotted on the first two canonical variate (CV) axes (Figs. 3 and 4 respectively). The variance-covariance matrices yielded a total of 13 canonical variates for males and 17 variates for females (Table 2). Thirteen and 17 of the variables exhibit statistically significant (P 0.01) morphological variation (Table 2). The first three CV axes account for a combined total

of 89.8% and 87.6% of the total morphologic variation (Table 2). Although canonical variates 4 through 13 and 17 are significant ($P \leq 0.01$), each provides little additional discrimination between localities; axes 4-5 account for the remaining 10.2% and 12.5% of the between-sample morphological variation (Table 2). Therefore, there is little distortion of the phenetic distances between populations if the character space is reduced from 22 dimensions to only two.

TABLE 1.—*Matrix of probability values*[1] *for F-tests for significant differences among the island fox samples. These tests are based on 22 cranial characters and the sexes were analyzed separately. Probability values of F-tests for the males are on the upper diagonal, females on the lower diagonal. Degrees of freedom for these tests were 13 and 194 for males and 17 and 190 for females.*

Locality[2]	Number Females	Number Males	SMI	SRI	SCrI	SNI	SCaI	SCII	SRII	SCrII	SNII
SMI	20	25		S	S	S	S	S	.01	S	S
SRI	32	30	S		S	S	S	S	.05	S	S
SCrI	67	68	S	S		S	S	S	S	.05	S
SNI	61	46	S	S	S		S	S	S	.01	.01
SCaI	16	21	S	S	S	S		S	S	.01	S
SCII	17	22	S	S	S	S	S		S	S	S
SRII	5	8	.05	NS	S	S	S	S		.05	.01
SCrII	1	6	.05	.05	.05	.01	.01	.05	.05		.01
SNII	12	10	s	s	s	s	s	s	s	.05	
SCIII	1	0	0.5	.05	.05	.05	.05	NS	.05	.05	.05
TOTAL	232	236									

[1]Probability notations used in this table are: S = significant ($P < 0.001$), NS = nonsignificant ($P > 0.05$), and intermediate P values are listed (i.e. $P \leq 0.05 = .05$).

[2]Locality acronyms are as follows: PRESENT-DAY SAMPLES: (SMI = San Miguel Island; SRI = Santa Rosa Island; SCrI = Santa Cruz Island; SNI = San Nicolas Island; SCaI = Santa Catalina Island; SCII = San Clemente Island; ARCHAEOLOGICAL SAMPLES: (SCrII = Santa Cruz Island; SRII = Santa Rosa Island; SNII = San Nicolas Island; SCIII = San Clemente Island).

For male foxes, samples cluster into three groups (Fig. 3): San Miguel (SMI) and Santa Rosa (SRI) Islands; Santa Cruz (SCrI), Santa Catalina (SCaI) and San Nicolas (SNI) Islands; and San Clemente Island (SCII). For both males and females, there is general correspondence between the position of present-day island samples in multivariate space and their actual geographic locations (Figs. 3 and 4). For males, island samples are distributed counter-clockwise from north to south starting with San Miguel in the upper right and ending with San Clemente in the lower right (Fig. 3). For females, present-day populations are similarily distributed north to south but are in a clockwise pattern (Fig. 4). In both CVAs degree of overlap among present-day Northern Channel Island populations (SMI, SRI, SCrI) appears to correspond to length of time that these islands have been isolated from each other (Figs. 3 and 4). Santa Cruz Island last separated from

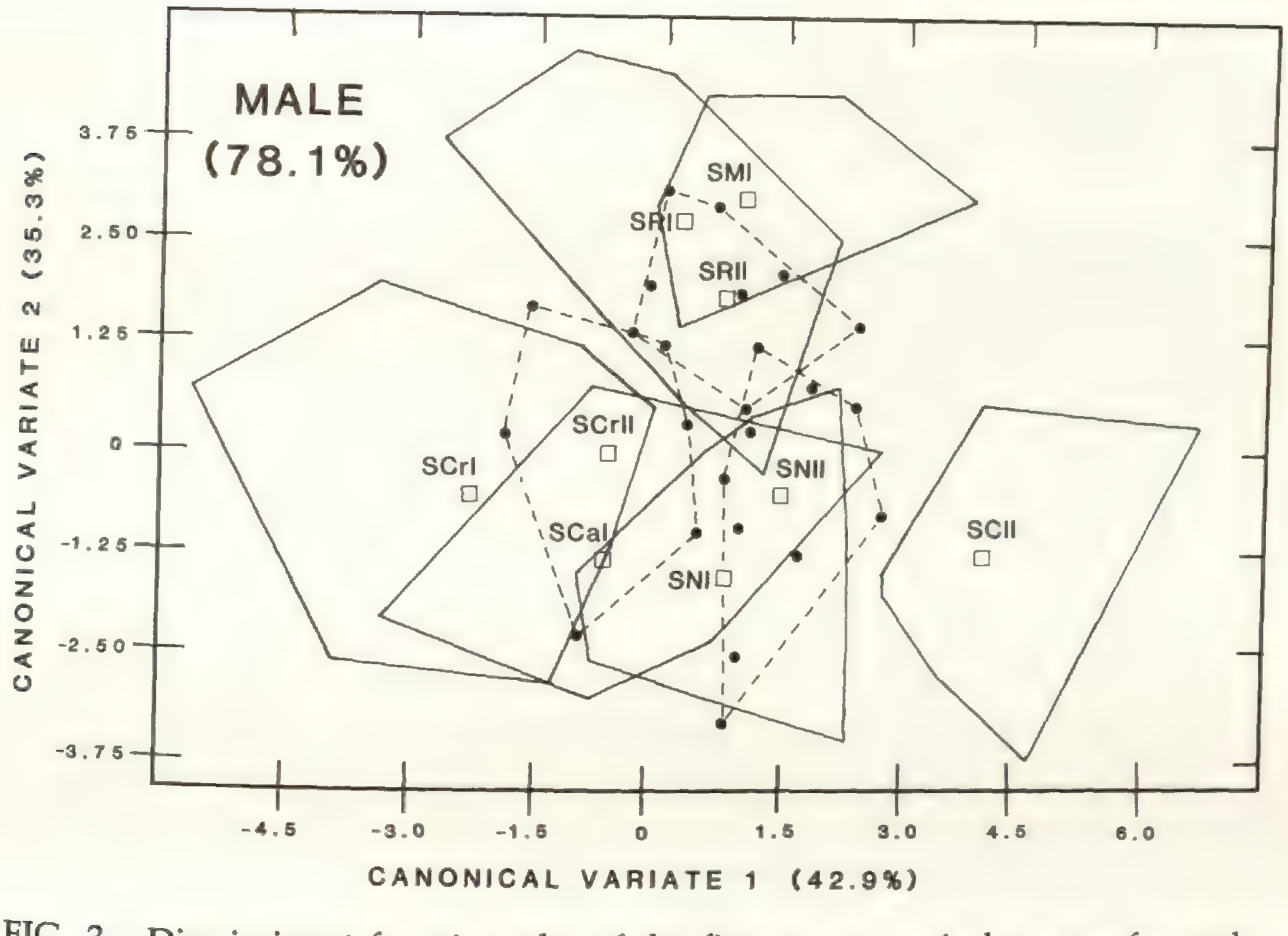

FIG. 3.—Discriminant function plot of the first two canonical vectors for male island foxes. Polygons enclose all of the individuals of each sample with solid lines used to denote present-day samples and dashed lines to denote archaeological samples. Open squares are used for sample mean centroids and solid black dots are used to note the location of archaeological specimens. Acronyms refer to samples described in Figure 1 and the Appendix.

Santa Rosa and San Miguel Islands about 2000 years before the latter two islands separated from each other (Johnson 1983).

Another prominent feature of both CVA plots (Figs. 3 and 4) is that archaeological samples are phenetically closer to the present-day sample from their island of origin. This can best be seen in the relative degree of overlap in present-day and archaeological samples from San Nicolas Island (Fig. 3). It is also apparent that group centroids for archaeological samples (SRII, SCrII, SNII) are situated, in multivariate character space, closer to each other than are group centroids for present-day samples (Figs. 3 and 4). The San Clemente Island sample is divergent in size (CV-1) but not in shape (CV-2) from other island samples (Fig. 3). Despite the size difference exhibited by San Clemente Island foxes, this population manifests the same basic skull shape as the other present-day populations, which suggests that foxes on San Clemente Island may have been isolated for a relatively short period of time, and as such, may not have had sufficient time to evolve substantive shape differences. This population may still be under constraints of a morphologic and genetic bottleneck. With the exception of Northern Channel Island samples, there does not appear to be a relationship between location of

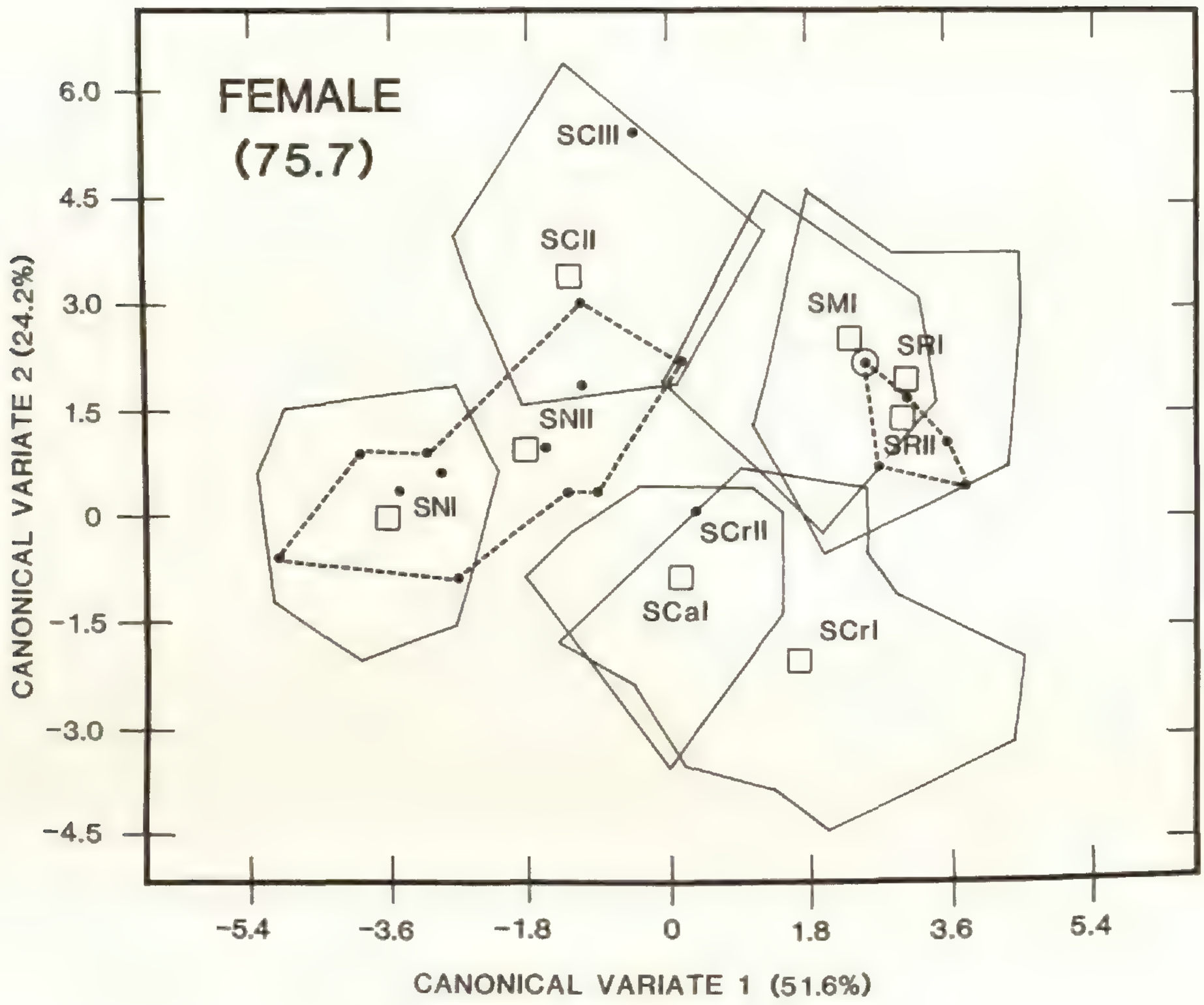

FIG. 4.—Discriminant function plot of the first two canonical vectors for female island foxes. Polygons enclose all of the individuals of each sample with solid lines used to denote present-day samples and dashed lines to denote archaeological samples. Open squares are used for sample mean centroids and solid black dots are used to note the location of archaeological specimens. Acronyms refer to samples described in Figure 1 and the Appendix. The fossil island fox specimen from the Upper Tecolote Member on Santa Rosa Island is represented by a circled black dot.

present-day island samples in multivariate space and actual geographic distances between islands. The Santa Catalina Island sample is phenotypically closer to Santa Cruz Island than to its geographically closest neighbor San Clemente Island (Figs. 3 and 4). Degree of divergence observed in present-day and archaeological island fox samples suggests that gene exchange was probably occurring between fox populations during the time of Indian occupation.

The female CV analysis differed from the male CVA in several ways. The San Nicolas Island sample was divergent in size (CV-1) but not shape (CV-2) from other island samples (Fig. 4). Overlap was evident between the San Nicolas Island archaeological sample (SNII) and the present-day San Clemente Island sample

TABLE 2.—*Logarithmized variables which were significant (P≤0.01) in distinguishing among the island fox samples. Character acronyms are the same as in Figure 2.*

Step Number	Variable	Wilk's lambda U-Statistic	Approx. F Value	df	Percent of [1] Inter OTU Variance
		MALE			
1	WBTYP	0.5230	37.58	5,206	42.9
2	MASW	0.2961	34.35	10,410	35.3
3	SORW	0.1666	34.34	15,564	11.7
4	NAMW	0.1035	33.09	20,674	6.4
5	MAXL	0.0705	31.35	25,752	3.8
6	NASL	0.0448	31.54	30,806	
7	PALW	0.0341	29.70	35,844	
8	CRAW	0.0266	28.26	40,870	
9	BASL	0.0213	26.94	45,889	
10	CRAD	0.0179	25.55	50,902	
11	ROSWC	0.0150	24.47	55,911	
12	TYML	0.0132	23.21	60,917	
13	ZYGW	0.0118	22.09	65,921	
		FEMALE			
1	WBTYP	0.3814	67.16	5,207	51.6
2	MASW	0.1953	52.03	10,412	24.2
3	SORW	0.0925	51.66	15,566	11.8
4	MAXL	0.0527	48.39	20,678	8.9
5	NAMW	0.0349	44.37	25,756	3.6
6	BASL	0.0262	40.13	30,810	
7	CRAD	0.0200	37.15	35,848	
8	ANAW	0.0161	34.55	40,875	
9	NASL	0.0130	32.60	45,893	
10	CRAW	0.0107	30.92	50,906	
11	ROSWO	0.0088	29.62	55,915	
12	MRTL	0.0075	28.36	60,922	
13	PALL	0.0065	27.16	65,925	
14	ROSWC	0.0056	26.12	70,928	
15	PALW	0.0049	25.15	75,929	
16	ZYGW	0.0043	24.47	80,929	
17	PORW	0.0038	23.68	85,928	

[1]This is the percentage of the between sample variance which is accounted for by the first five canonical vectors of interlocality phenetic variation.

(SCII) (Fig. 4). The present-day San Clemente Island sample was phenetically closer to San Miguel Island than to other Southern Channel Islands. Of particular interest in Figure 4 is the location of an apparent fossil fox specimen recovered from the Upper Tecolote geological formation on Santa Rosa Island, which has been estimated to date between 10,400 and 16,000 years of age (Orr 1968). This specimen, noted by the double circle in Figure 4, is situated between the SMI and SRI group centroids, which suggests that a small sized fox was present on Santa Rosa Island prior to currently accepted dates (about 9,000-10,000 years B.P.) for arrival of Native Americans to the Northern Channel Islands (Erlandson 1988). It also indicates that foxes have changed very little, at least in overall size and shape, during the last 16,000 years. Thus, foxes must have reached the Northern Channel Islands on their own prior to the arrival of Native Americans. As with the male CVA results, the broad overlap of SCaI, and SCrI as well as the slight overlap of SNII and SCII, and proximity of SCII to SMI all suggest that gene interchange was probably occurring between these islands during Indian occupation.

Degree of phenetic overlap in present-day and historic island fox samples was further assessed by comparing the proportion of individuals from each locality that were misclassified in the discriminant function analyses. For males, 189 of 212 present-day specimens (89%) were correctly classified to their *a priori* designated samples by the classification procedure of the discriminant function analysis (Table 3). The most distinctive locality samples were SNI (95.7% correctly classified), SCII (95.5% correctly classified), and SMI (92.0% correctly classified), whereas the least distinctive locality samples were SCaI (71.4% correctly classified) and SCrI (86.8% correctly classified). In the female analysis, 199 of 213 present-day specimens (93%) were correctly classified to their *a priori* designated samples (Table 3). The most distinctive samples for females were SNI and SCaI (100% correctly classified), and SCrI and SCII (94% correctly classified), whereas the least distinctive samples were SMI (80% correctly classified) and SRI (84.4% correctly classified).

Of fourteen SMI and SRI specimens that were misclassified by the discriminant function, all but two were classified to one of the adjacent Northern Channel Islands (Table 3). The degree of phenetic overlap between Santa Cruz, San Nicolas and Santa Catalina Islands is suggested by the 15 specimens which misclassified among these three islands (Table 3). The high proportion of correctly classified individuals in both of the CVAs suggests that present-day island fox populations have begun to diverge morphologically from one another. Given the high proportion of correct classifications in both the male and female analyses, it appears that these two discriminant functions should classify the archaeological samples with a high degree of precision.

Classification analysis of archaeological material further suggests that Indians have played a major role in determining present island fox zoogeography. Eight of 13 Santa Rosa Island archaeological specimens (SRII) classified with the present-day SRI sample whereas the remaining five specimens classified with SMI (Table 3). The fossil specimen classified with the present-day SRI sample. Male archaeological specimens from Santa Cruz Island (SCrII) exhibited a much broader

TABLE 3.—*Jackknifed discriminant classification of individual island fox, based on 22 skull variables. Rows are actual groups and columns are predicted groups. The archaeological material is classified in relation to the discriminant equation established from the six present-day island samples. Samples acronyms are the same as those in Table 1.*

Actual Locality	N	Percent Classified Correctly	Predicted Locality SMI	SRI	SCrI	SNI	SCaI	SC1I
			MALE					
SMI	25	92.0	23	2				
SRI	30	90.0	2	27		1		
SCrI	68	86.8		2	59	5	2	
SNI	46	95.7		1	1	44		
SCaI	21	71.4	1		2	3	15	
SC1I	22	95.5	1					21
SRII	8	—	3	5				
SCrII	6	—	1	1	2	1	1	
SNII	10	—	1			9		
TOTAL	236							
			FEMALE					
SMI	20	80.0	16	3	1			
SRI	32	84.4	3	27	1	1		1
SCrI	67	94.0		2	63	1		1
SNI	61	100.0				61		
SCaI	16	100.0					16	
SC1I	17	94.1				1		16
SRII	5	—	2	3				
SCrII	1	—			1			
SNII	12	—	1	1		7	2	1
SC1II	1	—						1
TOTAL	232							

phenetic range, with specimens classifying to most of the island samples (Table 3). The San Nicolas Island archaeological material (SNII) showed overlap with present-day samples from San Miguel, Santa Catalina, and San Clemente Islands (Table 3). The archaeological specimen from San Clemente Island classified with the present-day San Clemente Island sample.

In summary, results of two canonical variates analyses showed that each of six present-day island fox populations exhibit a moderate degree of phenetic divergence. Small island foxes have been present on Santa Rosa Island for at least

10,400–16,000 years. The broad overlap observed between some island samples (i.e., SMI–SRI, SCrI–SCaI and SNI–SCaI), coupled with the occurrence of misclassifications between these overlapping samples, suggests that gene exchange has probably occurred in the past between these islands. Phenetic affinities of archaeological material from three of the islands (SNI, SCrI, SRI) suggests that Indians played a role in determining present island fox zoogeography.

Results-Archaeological Occurrences.—Although and examination of faunal remains recovered from Channel Island archaeological sites provides additional information which favors the hypothesis that Indians have played a role in the dispersal of island foxes, a number of problems were encountered with these samples. Since the majority of archaeologists prior to the late 1950s were not interested in recovering or documenting the occurrence of faunal remains, little faunal material was saved. Most early excavators used screens or mesh sizes which were too large to catch any small, and most medium-sized, faunal material. Most faunal remains which were saved lacked provenience data. Finally, most early archaeologists saved only the largest or most impressive faunal material (e.g. skulls and mandibles).

Despite these shortcomings, a number of observations can be made from the archaeological record. Island fox remains were found in 27 archaeological sites and one fossil locality on six of the eight islands (Table 4). These sites ranged in age from 7,500 years B.P. to historic times. Foxes have not been found in archaeological contexts on Anacapa or Santa Barbara Islands, but were present on Santa Cruz and Santa Rosa Islands throughout Indian occupation. Foxes do not appear in the archaeological record on the Southern Channel Islands until about 3,800-2,200 years B.P. The presence of fox remains only in the upper levels of Middle to Late Period sites on San Clemente, Santa Catalina and San Nicolas Islands suggests that they were probably introduced to these islands by Native Americans. Finally, the recovery of a fox skull from a late Holocene geologic formation on Santa Rosa Island leads me to conclude that small-sized island foxes were present on Santa Rosa Island prior to the arrival of Native Americans.

Unmodified remains. Unmodified fox remains are rare on San Miguel Island, and have been found at only three sites (Table 4). At SMI–525 a burned ulna was recovered from a stratum which was bracketed between corrected radiocarbon dates of 2,981–1,724 yrs. B.P. (Table 4). On Santa Rosa Island, unmodified fox remains have been recovered from one fossil locality and five archaeological sites (Table 4). The absence of adequate provenience data and detailed field notes hampered a more thorough analysis of fox material found in Santa Rosa Island archaeological sites. As a result, I can only say that foxes were present on Santa Rosa Island in Early (7,500 to 3,500 B.P.) through Late Period (800–120 B.P.) sites. Also, the occurrence of an island fox skull in the Upper Tecolote Member of the Santa Rosa Island Formation, which dates from 10,400 to 16,000 years B.P., suggests that foxes must have reached the Northern Channel Islands on their own prior to the arrival of Native Americans 9,000–10,000 years ago.

TABLE 4.—*Island fox skeletal remains recovered from Channel Island archaeological sites.*

Site[1] Number	Provenience	Chronological Placement	Age (years before present)[2] Radiocarbon	Estimated	Skeletal elements present	Sources
SAN MIGUEL ISLAND (UCLA Archaeological Survey Site Numbers)						
SMI-1	12-18''	Early/Middle	6,270-3,240	7,000-3,000	1 R. radius and 1 R. hemi-mandible fragment	Erlandson (1989)
SMI-261		Early/Middle	10,260-2,990	7,500-800		Walker (1978), Collins (unpubl. data), Erlandson (1988)
	Unit E-3, 0-24''				7 limb bones (may be from one individual)	
	Unit F-2				1 pelvis, 1 R. humerus	
	Unit F-4, 12-18''				1 caudal vertebrae	
	Unit F-6, 36-42''				1 caudal vertebrae	
	Unit G-3, 18-24''				1 radius	
	Unit G-5, surface				1 pelvic fragment	
SMI-525	Profile-D, Stratum 14	Middle/Late	3,020-1,460	3,080-770	1 burned proximal end of ulna	Walker and Snethkamp (1984)
SANTA ROSA ISLAND (UCLA Archaeological Survey Site Numbers)						
SRI-1	Cemetery A, Burial 1	Early		7,500-3,500	4 skulls (3 with mandibles, 2 mandibles only	Orr (1968)
SRI-2A		Middle/Late	1,910-800	1,600-1,200	1 ulna	Orr (1968) King (1981), Glassow et al. (1983)
	Cemetery A, Burial 4, Level 2				5 partial skulls (3 with mandibles),	Orr (1968)
	Cemetery A, Plot C-2	Late			1 complete skeleton	King (1981)
SRI-2B	Cemetery B, Trench B	Late	600 ± 70	700-550	3 partial skulls (2 with mandibles, assorted postcranial elements	Glassow et al. (1983), Orr (1968), King (1981)
SRI-3	none	Early	7,230-4,000	7,500-3,500	2 skulls, 1 ulna	Glassow et al. (1983), Orr (1968), King (1981), Erlandson (1988, 1989)

TABLE 4.—*Island fox skeletal remains recovered from Channel Island archaeological sites. (continued)*

Site[1] Number	Provenience	Chronological Placement	Age (years before present)[2] Radiocarbon	Estimated	Skeletal elements present	Sources
SRI-4	none	Early/Middle	6,670-2,160	7,500-800	1 partial skull	Glassow et al. (1983), Orr (1968), King (1981)
SRI-41	Cemetery C, Sec. II	Late		800-120	1 skull with mandible	Orr (1968), King (1981)
Tecolote Cyn.	Upper Tecolote Member	Late Pleistocene	16,000-10,400+		1 skull with mandible	Orr (1968)
SANTA CRUZ ISLAND (University of California, Berkeley Site Numbers)						
SCrI-3	(Olson's excavations)	Early		4,300-3,300		Hoover (1971), Glassow (1980), Collins (unpubl. data
	Pit A, 0-2′				1 R. mandible, 1 partial pelvis	
	Pit F, 0-1′				1 humerus, 1 radius	
SCrI-3	(Van Valkenburgh's excavations)	Early		5,400-4,300	1 complete skeleton found in a grave (burial)	Van Valkenburgh (1933), King (1981)
SCrI-3	(Wilcoxon's excavations)	Early/Middle	5,325-1,315	5,500-3,500		Hoover (1971),
	Unit 6A, Central, 70-80cm			3,500	1 skull, 14 post cranial elements	Breschini et al. (1988), Wilcoxon
	Unit 6A, Central, 100-110cm			3,500	4 metacarples	(pers comm), Collins (unpubl. data)
	Unit 6B, North, 40-50 cm			5,500-3,500	fragments from 1 skull and pelvis	
	Unit 6B, North, 70-80cm			5,500-3,500	portion of left pelvis	
	Trench 6, 0-40cm			3,500	3 partial mandibles, 1 radius, 1 axis vertebrae, and 5 teeth	
	Trench 2A, Central, 60-70cm			5,500-3,500	1 right anterior portion of ramus (burnt)	
	Trench 2A, Central, 100-110cm			5,500-3,500	1 R. anterior portion of mandible	
				5,500-3,500	1 R. anterior portion of mandible	

	Unit 11-B, Central, 210-220cm		5,500	*fragments of R. mandible, ½ of a pelvis*	
	Unit 32-B, South, 50-60cm		3,500	2 mandibles, piece of skull	
SCrI-83	(Roger's/Olson's excavations)	Middle	3,500-800		Hoover (1971), King (1981), Collins (unpubl. data)
	Site 3, Pit A, Sec 2, 2-4'			1 R. mandible	
	Site 3, Pit A, Sec 3, 2'-4'2''			2 partial skulls, 1 R. mandible	
	Site 3, Pit DD-1, 3'			complete skull (ritual burial)	
	Site 3, C-21, 18''		750-650	skull	
	Site 3, X3/X2, 3'9''			1 partial cranium (posterior portions)	
SCrI-100	(Olson's excavations)	Middle/Late	900-700		Hoover (1971), King (1981), Collins (unpubl. data), Fisher (1930)
	Pit B-9, Casual			partial cranium	
	Pit C-11, 3'			lower premolar 3	
	Pit C-14, 5'			1 femur, 1 thoracic vertebrae	
	Pit D-5			2 skulls (Associated with a human burial)	
	Pit D-8			1 femur, 1 tibia, 1 complete pelvis, 1 crushed cranium	
	Pit E-2			posterior portion of the cranium	
	Pit H, 3'3'6''			3 femurs, 2 partial pelvis, 2 ulna, 1 tibia, 2 radius, 2 vertebrae, fragments of skull	
	Pit H, 3'6''-4'			1 pelvis, 1 femur, 1 ulna, 1 radius, pieces of a skull	
	Pit H, 4'6''-5'			1 lumbar vertebrae	
	Pit H, 5'-5'6''			posterior portion of skull, 1 lumbar vertebrae	
	Pit H, 6'6''-7'			3 postcranial elements, fragments of skull and lower mandible	
	Pit H, 7'-7'6''			partial pelvis	

TABLE 4.—*Island fox skeletal remains recovered from Channel Island archaeological sites. (continued)*

Site[1] Number	Provenience	Chronological Placement	Age (years before present)[2] Radiocarbon	Estimated	Skeletal elements present	Sources
	Pit H, 7′6″-8′ Casual				1 atlas vertebrae 4 partial skulls, 1 L. mandible	
SCrI-122	(Olson's excavations) Pit A, Level I, 2′ Pat A, Level II, 1′4″	Late		800-120	 1 partial skull 1 skull	Hoover 1971), King (1981), Collins (unpubl. data)
SCrI-131	Pit 4, 3′-5′2″	Late		800-120	2 skulls (associated with human burials)	Hoover (1971), King (1981)
SCrI-147	(Olson's excavation) Pit A, 1′-2′	Late		800-120	 5 postcranial elements, fragments of juv. skull	Hoover (1971), King (1981)
SCrI-147	(Spaulding's excavation) Unit 1, E. Trench, Cut 6, Sec. N. Unit 1, W. Trench, Cut 23, Sec. L. Unit 1, Entire Trench, Cut 30 Unit 1, Central Block, Cut 9 Column Sample, Level J Unit 2, Cut 18	Middle/Late	2,975-425 1,065 ± 110 970-935 ± 100 1,100 ± 100	3,500-700	 1 lower canine 1 L. mandible 1 radius, 1 ulna (butcher marks present) 1 juvenile humerus skull 2 femurs, 1 ulna, 1 radius, 1 humerus, posterior portion of skull	Breschini et al. (1988), Collins (unpubl. data)
SCrI-206	Level J				posterior elements of skull	Collins (unpubl. data)

SAN NICOLAS ISLAND (UCLA Archaeological Survey Site Numbers)

SNI-7	none				20 complete/partial skeletons (20 skulls)	Orr (1948 Field Notes)
SNI-II	Mound A, upper component Base of midden	Middle/Late	2,220-573 ± 110		1 R. mandible, 1 proximal epiphysis of R. tibia partial skull and skeleton eroding out of base of midden (SBMNH 2304)	Bleitz-Sanburg (1987) Kovach (pers. comm.)
SNI-51	18-30''	Late		800-120	1 skull, 1 mandible	Rozaire (1959)
SNI-119	Pit 2, 4-18''				1 mandible, 1 L & R humerus, 1 femur	Collins (unpubl. data)
Unspecified ''Indian Midden''					30 whole/partial skulls, 9 mandibles	Collins (unpubl. data)
SANTA CATALINA ISLAND (UCLA Archaeological Survey Site Numbers)						
SCaI-17	none	Early/Middle	3,880 ± 250	3,880-800	2 mandibles and fragment of 1 pelvis	Meighan (1959), Drover et al. (1979)
SCaI-45	10-40cm	Middle		1,450-1,050	2 radius, 1 scapula	Rosen (1980)
SCaI-137	Unit 2, level 2 and 3	Late	270-330 ± 100		1 L. and 1 R. tibia, distal end of humerus	Rosenthal (1988), Cottrell et al (1980)
SAN CLEMENTE ISLAND (UCLA Archaeological Survey Site Numbers)						
Pyramid Cove	(Test Pit) 18''	Late		800-120	1 tibia	Woodward (unpubl. notes)
SCII-43C	Eel Point Area C, Unit 4, Feature D, 160-175cm Area C, Unit 6, Feature 0, 175-190cm Area C, Test Pit 2, (Ext. A), 120-135cm	Early/Middle	4,300-3,005 3,400		2 complete pup skeletons (burials) partial adult skeleton (burial) 25 miscellaneous postcranial bones representing one individual	Salls (1988)
SCII-48	0-29'	Historic		800-120	1 humerus	McKusick and Warren (1959)

TABLE 4.—*Island fox skeletal remains recovered from Channel Island archaeological sites. (continued)*

Site[1] Number	Provenience	Chronological Placement	Age (years before present)[2] Radiocarbon	Estimated	Skeletal elements present	Sources
SCll-1215	Nursery Site Unit 4-5, W10, 50-60cm N69-70, W13, 30-40cm	Middle/Late	1,490 ± 30	3,500-800	partial adult skeleton (burial ?) 1 miscellaneous bone	Salls (1988), Bleitz (pers. comm.)
SCll-1524	Lemon Tank Unit O-N, 18E, 40-50cm Unit O-N, 22E, 20-30cm Unit O-N, 26E, 0-10cm Unit O-N, 34E, 0-10cm Unit 7S, 15E, 20-30cm, Feature F6 Unit 7S, 17E, 10-20cm, Feature 125 Unit 8S, 17E, 10-20cm, Feature 96 Unit 13S, 15E, 30-40, Feature 48 Unit 13S, 19E, 30-40cm, Feature 140 Unit 17S, OW, 20-30cm, Feature 109	Late		800-120	1 broken tooth 2 miscellaneous bones Burial ? 1 pup (10 bones) 1 miscellaneous bone fragment Burial 1 pup with 8 beads Burial 1 adult Burial 1 pup Burial 1 pup with numerous artifacts Burial 1 pup Burial 1 pup	Rabb (pers. comm.), Bleitz (pers. comm.)

[1]For site concordance of Northern Channel Island Sites with other numbering systems see Glassow (1977).

[2]Unless otherwise noted the radiocarbon dates listed here are all uncorrected dates and most of the estimated ages used in this table are taken from King (1981:Table 1) Early: 7500-3500 B.P., Middle: 3500-800 B.P., Late: 800-120 B.P.

+The one fossil island fox specimen was excavated by Orr from the upper Tecolote member in Tecolote Canyon on Santa Rosa Island. This geological stratum was dated to 10,400-16,000 radiocarbon years B.P. (Orr 1968). This particular fossil was not found to be associated with any archaeological material.

Seven Santa Cruz Island sites contained unmodified island fox remains (Table 4). Most of the material recovered from these sites had provenience data. Fox remains were recovered from Early, Middle and Late Period sites, which suggests that they were present on Santa Cruz Island for at least as long as Native Americans. Fox remains were found throughout all levels of SCrI–3 and were dated, using temporally diagnostic artifacts, at 5,500–3,500 years B.P. At SCrI–147, a Late Period site, fox remains were recovered from levels that were radiocarbon dated at 970 to 1,100 ± 100 yrs. B.P. (Table 4).

While fox remains are common in archaeological sites on San Nicolas Island, most of the material lacks provenience or site data and is listed only as having come from "Indian middens." Unmodified fox remains with site data have been recovered from four Late Period sites on San Nicolas Island (Table 4). Orr (1948, unpubl. field notes) collected twenty partial and/or complete fox skeletons from SNI–7 but did not record any provenience data for this material. The earliest record of foxes on San Nicolas Island comes from SNI–11 where two fox bones were found in the upper stratum of mound A, which has been radiocarbon dated at 2,220–573 ± 110 yrs. B.P. (Bleitz–Sandburg 1987). Occurrence of fox material only in the upper levels of San Nicolas Island archaeological sites, coupled with the large proportion of specimens recovered from the surface of "midden" sites, implies that island foxes are a fairly recent (i.e., post 2,200 yrs. B.P.) introduction to the island.

Fox remains are rare in archaeological sites on Santa Catalina Island. They have been recovered from one Middle and two Late Period sites (Table 4). Fox bones from the Little Harbor site (SCaI–17) lack provenience data. Therefore, it is possible to say only that foxes first appear in the archaeological record on Santa Catalina Island sometime between 3,880 to 800 years B.P., which is believed to be the length of time that the Little Harbor Site was inhabited (Meighan 1959). The absence of fox from Early Period sites on Santa Catalina Island suggests that they were probably introduced to the island by Indians sometime between 3,880 and 800 years B.P.

On San Clemente Island, unmodified fox remains have been found in four Late Period/Historic sites, and one Early/Middle Period site (Table 4). The occurrence of fox remains at the Eel Point Site (SCII–43C) below a level that had a reservoir–adjusted radiocarbon shell date of 3,400 yrs. B.P. (Salls 1988) suggests that foxes first reached San Clemente Island sometime between 4,300 and 3,400 years B.P. when this portion of the Eel Point Site was believed to have been occupied (Salls 1988).

Intentional burials. A total of 39 intentional burials of island foxes have been recovered from Santa Rosa, Santa Cruz, San Nicolas and San Clemente Islands (Table 4). On the Northern Channel Islands several fox burials have been directly associated with human remains; this has not been the case on the Southern Channel Islands. Nearly all of the fox material recovered by Orr from Santa Rosa Island sites was found during cemetery excavations (Orr 1968). However, lack of detailed field records and adequate provenience data prevented further analysis. Occurrence of fox remains in human cemeteries on Santa Rosa Island suggests possible existence of ritual/ceremonial customs associated with foxes.

Well-documented excavations on Santa Cruz Island provide evidence of seven direct human-island fox burial associations. Three fox burials recovered by Olson suggest ceremonial or ritualistic practices (Olson unpubl. Field Notebook 3). In the first, two fox skulls were associated with a child burial. In the second, a fox skull was situated between the pelvises of an adult man and woman. In the third, a fox skull was found wrapped in a mat fragment with two bone tubes which were coated with asphalt and wrapped with string (Hoover 1971). Several other investigators have observed foxes in burial contexts on Santa Cruz Island. According to Moodie, the burial of a fox skull (LACM-30754) between two abalone shells could represent burial of personal belongings, charms and/or a pet (Moodie unpubl. Field Notes). A complete fox skeleton was found in a human grave at SCrI-3 while two human burials at SCrI-131 each contained a fox skull (Van Valkenberg 1933). The island fox/human burial associations recorded in the archaeological record on Santa Cruz Island suggest that Chumash on Santa Cruz Island assigned some religious or ceremonial significance to island foxes and thus gave then special mortuary treatment.

Although a number of island fox burials have been recorded for San Nicolas Island, none were directly associated with human remains or with artifacts. Perhaps the most notable find was the recovery of 20 partial and/or complete island fox skeletons from SNI-7 (Orr 1948, unpubl. Field Notes). Given the large number of specimens and their proximity to one another within the site, I believe that these foxes were probably buried for disposal after having been skinned for their pelts. Butcher marks on some of the specimens are consistent with this interpretation. The archaeological record on San Nicolas Island suggests that foxes were not given any special ceremonial or ritual status by the Gabrielino (Nicoleño) Indians.

Although eleven fox burials have been recovered from three San Clemente Island sites (Table 4), none were found in direct association with human remains. At the Eel Point Site (SCll-43C) a dual burial of two fox pups was associated with ritual offerings of hematite and beads whereas the partial skeleton of an adult female fox was recovered without artifacts. The skeleton of an adult fox was found at the Nursery Site (SCll-1215). Recent excavations at the Lemon Tank site (SCll-1524) have uncovered a total of 20 ritual animal burials (Salls and Hale in litt.). Seven of these were foxes. Six were very young pups and two were associated with ritual offerings. The pup recovered from Unit 13S 15E was buried with a large abalone shell which contained a scraper, 22 beads, a bowl, a pendant, and drilled abalone shell (Table 4). Fox burials found at the Lemon Tank site probably represent ritual burials that were associated with canid killing or mourning ceremonies (Salls and Hale in litt.).

DISCUSSION

Geologic and Eustatic Evidence of Landbridges in the Southern California Borderland.— Geologists have not found evidence to suggest that there were any mainland-to-island landbridges connecting the California Channel Islands to the mainland during the Pleistocene (Junger and Johnson 1980; Vedder and Howell 1980; Johnson

1983). To produce landbridges, the present sea level would have had to have been 232 meters lower than it is at present. This is much lower than current estimates of -120 to -165 m for glacially controlled lowering of sea level during the Pleistocene (Johnson 1978).

The Southern Channel Islands were never connected to one another, to the mainland, nor to any of the Northern Channel Islands during the Pleistocene (Johnson 1983). The only islands that were connected then were the four Northern Channel Islands, which coalesced a number of times during the glacial episodes of the Pleistocene to form the superisland known as Santarosae. Santarosae last existed during the maximum Wisconsin glaciation of 24,000-14,000 B.P. Sea level began dropping about 28,000 B.P. and rapidly declined to a low of -120 m by 17,000-18,000 B.P. (Johnson 1978; 1983). The Santarosae landmass began to break up when sea level began rising about 16,000-17,000 B.P. (Vedder and Howell 1980; Johnson 1983). Anacapa Island was the first to separate from the Santarosae landmass about 12,000 B.P., followed by Santa Cruz Island about 11,500 B.P., and finally by San Miguel and Santa Rosa Islands about 9,500 B.P. (Johnson 1978; 1983). The present sea level was reached about 6,000 to 7,000 years ago. Thus, Santa Cruz Island has been isolated from the other Northern Channel Islands for about 2,000 years longer than San Miguel and Santa Rosa Islands have been isolated from each other. The recent geological record is important for understanding the origin and dispersal of island foxes because longer isolation could theoretically be evidenced by greater morphological divergence and because landbridges cannot be used to explain the dispersal of island foxes to the Southern Channel Islands.

Biotic Dispersal Mechanisms.—In the absence of landbridges, alternative explanations are needed to explain the dispersal of foxes to all six of the islands on which they presently occur. Overwater dispersal, which could occur by swimming, rafting or transport via human watercraft, offers the only plausible mechanism to explain present distribution of foxes on six widely separated islands. There is no evidence to suggest that foxes are good swimmers or that they could swim a distance of 6 km, which was probably the narrowest distance to occur during the Pleistocene between the mainland and any of the islands. Wenner and Johnson (1980) present a persuasive argument that overwater dispersal via debris rafts was probably the mechanism by which mainland foxes first colonized one of the Channel Islands. The fact that an already small-sized island fox was present on Santarosae at least 16,000 years B.P., coupled with the occurrence of small-sized fox bones throughout Indian occupation on Santa Rosa and Santa Cruz Islands, infers that Native Americans were not responsible for the initial transport of foxes from the mainland.

Dispersal of foxes to the Southern Channel Islands on rafts of floating debris, either directly from the mainland or from the Northern Channel Islands, is far more difficult to accept since this would require three independent successful colonization events. Evidence from both the archaeological record and the phenetic analyses reported here suggests that Indians were probably responsible for moving foxes from the Northern to the Southern Channel Islands.

Hypotheses on island colonizations. Although questions persist relative to how and when island foxes colonized the islands, morphological similarities observed between present-day and archaeological fox samples, coupled with the record of island foxes in archaeological sites provide clues relative to the role which Indians played in establishing foxes on some of the islands, and infer probable scenarios for the historical colonization sequence of the islands. Misclassification of archaeological specimens to islands other than where they were excavated from provides evidence of possible gene flow and routes for colonization.

Several lines of evidence refute a human assisted dispersal of gray foxes from the mainland to the Channel Islands. The recovery of a small fossil island-fox-sized skull from Santa Rosa Island, dated at 10,400 to 16,000 radiocarbon years B.P. (Orr 1968), coupled with the occurrence of island fox remains in middens on Santa Cruz and Santa Rosa Islands throughout the time of Indian occupancy (Table 4), suggest that gray foxes reached the Northern Channel Islands on their own accord by chance overwater dispersal prior to the arrival of Native Americans 9-10,000 years B.P. Several lines of evidence argue against a pre-Holocene colonization of the Southern Channel Islands by foxes. The absence of large gray-fox-sized fossils, along with the occurrence of island fox remains only in Middle and Late Period archaeological sites on the Southern Channel Islands (Table 4), infers that foxes from the mainland were probably not used by Native Americans to establish fox populations on San Nicolas, Santa Catalina and San Clemente Islands.

Determining the time of initial colonization of the Northern Channel Islands by gray foxes is extremely difficult given the poor fossil record for these islands. However, the morphologic data leads me to conclude that gray foxes probably first reached the Northern Channel Islands in the late Pleistocene (i.e. 40,000-25,000 B.P.) just prior to the period of maximum Wisconsin glaciation of 24,000-14,000 B.P. During a relatively short period of isolation (i.e. 10,000 yrs.) these foxes rapidly evolved to their present small body size as a result of unique selection factors such as inbreeding and resource limitations. This rapid rate of change could account for the absence of fossil evidence of intermediate forms between gray foxes and island foxes, since the principal size change probably took place in a relatively short time frame. Island foxes weigh 31 to 46% less than mainland gray foxes. That such a significant reduction could occur in less than 40,000 years is not too surprising. Evidence from elsewhere in the world suggests that changes in body size in small allopatric populations of mammals on islands occurs very rapidly (Sondaar 1977; Marshall and Corruccini 1978). Red deer (*Cervus elaphus*) on Jersey Island off the coast of France, for example, showed a sixfold weight reduction in less than 6,000 years (Lister 1989). The presence of a moderate amount of morphologic divergence (Figs. 3 and 4) in present-day island fox populations, which range in age from 2,200 to 11,500 years old, is further proof that island foxes are capable of a fairly rapid rate of evolution.

Small-sized island foxes would have dispersed to the remainder of the Northern Channel Islands during the late Quaternary when these islands last coalesced to form the superisland known as Santarosae around 24,000 to 18,000 B.P. (Johnson 1983). As the glaciers began receding at the end of the last Wiscon-

sin Glacial epoc, 16,000 to 17,000 years ago, Santarosae began to break up. Island foxes became isolated on Santa Cruz Island about 11,500 B.P. and then on San Miguel and Santa Rosa Islands at 9,500 B.P. The degree of morphological divergence observed in present-day Northern Channel Island fox populations correlates with the recent geologic history as evidenced by the slight divergence in the Santa Cruz Island population and the broad overlap in the San Miguel and Santa Rosa Island populations (Figs. 3 and 4). Following the arrival of Native Americans 9,000-10,000 B.P., genetic interchange of island foxes among the Northern Channel Islands probably occurred via Indian transport. Misclassification of present-day foxes between these three islands (Table 3) indicates that Indians may have been moving foxes between the Northern Channel Islands.

Setting exact times for the colonization of the Southern Channel Islands is more difficult since the fossil and subfossil records are incomplete. If foxes were present on any of the Southern Channel Islands prior to the arrival of Native Americans, then I would have expected their remains to be present in middens throughout Indian occupation like they are on the Northern Channel Islands. This is not the case. Rather, foxes do not appear in an archaeological context until about 3,400 B.P. on San Clemente Island and 2,200 B.P. on San Nicolas Island (Table 4). Island foxes show up on Santa Catalina sometime between 3,880 and 800 B.P. (Table 4). Thus, island foxes probably reached the Southern Channel Islands via transport in Indian watercraft well after the arrival of Native Americans.

The morphometric analyses also support a fairly recent, post-Holocene introduction of island foxes from the Northern Channel Islands to the Southern Channel Islands by Native Americans. Morphologic overlap between present-day San Nicolas, Santa Catalina and Santa Cruz island fox populations (Figs. 3 and 4), along with the misclassification of specimens between these three islands (Table 3), suggests that foxes from Santa Cruz Island may have been used to establish the San Nicolas and Santa Catalina populations. Classification of archaeological specimens from San Nicolas Island to four other island samples (Table 3) indicates that island foxes were probably occasionally being transported between the islands by Indians through the Late Period (800–120 yrs. B.P.).

Determining the origin and setting an exact time for the colonization of San Clemente Island by island foxes is problematic. Grinnell *et al.* (1937) mention that Salvador Ramirez claimed to have introduced a pair of island foxes from Santa Catalina Island to San Clemente Island in 1875. However, W.E. Greenwell observed foxes on San Clemente Island in 1860 (Johnson 1975). This, along with J.G. Cooper's capture of an island fox on San Clemente Island in July 1863, establishes that island foxes were present on San Clemente Island prior to Ramirez's efforts. The occurrence of island foxes in five archaeological sites on San Clemente Island offers further evidence to suggest that foxes were present on this island prior to 1875. The recovery of island fox bone material from the Eel Point Site (SCII-43C) below a level which has been radiocarbon dated at 3,400 yrs. B.P. suggests that island foxes were introduced to this island by Indians sometime after 4,300 B.P. but before 3,400 B.P., which is the length of time that this portion of the SCII-43C site is believed to have been inhabited (Salls 1988).

Whether the population on San Clemente Island resulted from a single or multiple colonizations from one of the other Southern Channel Islands or from

one of the Northern Channel Islands remains problematical. Multiple discriminant function analysis of present-day island fox populations does indicate slight divergence of the San Clemente population from all other island fox populations. This, coupled with the high proportion of correctly classified individuals (94–96%) in the Jackknifed classification procedure of the discriminant function analyses (Table 3), suggest that the San Clemente Island population may still be under the constraints of a founder effect resulting in low intra-population variability and high self-fidelity in Jackknifed classification. Small population size coupled with founder effects may have acted to limit morphological variability in the fox population on San Clemente Island. Further work is needed on this population, including examination of allozymic variability, to shed additional light on its origin.

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APPENDIX

List of Specimens Examined

The following is a list of island fox (*Urocyon littoralis*) specimens examined in the morphometric analyses. This list is arranged according to present day samples and archaeological samples. Sample acronyms along with sample size for each locality sample are noted in parentheses. For the present day samples (localities 1-6) only adult specimens (age classes 3-6) and specimens with complete data sets are included in this listing, while all specimens measured for the archaeological analyses are listed. A listing of the complete names for collections in which specimens are housed can be found in the Acknowledgments. All localities listed are from southern California and are indicated on Figure 1.

Locality 1 (SMI; N=37). Santa Barbara Co., San Miguel Island: 3 (CSULB), 4 (LACM), 9 (MVZ), 15 (SBMNH), 4 (SDMNH), 2 (USNM).

Locality 2 (SRI; N=59). Santa Barbara Co., Santa Rosa Island: 16 (LACM), 1 (MPM), 8 (MVZ), 14 (SBMNH), 12 (UCLA), 1 (UILL), 7 (USNM).

Locality 3 (SCrI; N=128). Santa Barbara Co., Santa Cruz Island: 2 (CSULB), 13 (LACM), 7 (MVZ), 40 (SBMNH), 1 (SDMNH), 56 (UCLA), 5 (UCSB), 3 (USNM).

Locality 4 (SMI; N=104). Ventura Co., San Nicolas Island: 1 (CSULB), 1 (KU), 44 (LACM), 6 (MVZ), 23 (SBMNH), 5 (SDMNH), 18 (UCLA), 4 (UCSB), 2 (USNM).

Locality 5 (SCaI; N=37). Los Angeles Co., Santa Catalina Island: 1 (FMNH), 14 (LACM), 6 (MVZ), 1 (SBMNH), 5 (SDMNH), 1 (UCD), 1 (UCLA), 8 (USNM).

Locality 6 (SClI; N=39). Los Angeles Co., San Clemente Island: 13 (LACM), 1 (MCZ), 1 (MVZ), 7 (SBMNH), 5 (SDMNH), 4 (UCLA), 8 (USNM).

SRI Archaeological Sample (SRII; N=20). Santa Barbara Co., Santa Rosa Island: Site 1 (N=2, SBMNH); Site 2, trench B (N=1, SBMNH); Site 2 (N=5, SBMNH); Site 3 (N=2, SBMNH); Site 4 (N=1, SBMNH); Site 25 (N=1, SBMNH); Site 41 (N=2, SBMNH); Site unspecified (N=5, SBMNH); "Indian Midden on Santa Rosa," Site 106 (N=1, LACM).

SCrI Archaeological Sample (SCrII; N=21). Santa Barbara Co., Santa Cruz Island: Christie's, Site 3 (N=5, SBMNH); Cochie Prietos (N=2, SBMNH); Site 3 (N=1, LOWM); Site 83 (N=1, LOWM); Posa Landing, Site 100 (N=6, LOWM); Prisoner's Harbor, Site 240 (N=2, UCSB-AC); Site 333 (N=1, UCSB-AC); Willows, Site 2 (N=2, SBMNH); "Santa Cruz Island Kitchen Middens" (N=1, LACM).

SNI Archaeological Sample (SNII; N=53). Ventura Co., San Nicolas Island: Site 7 (N=20, SBMNH); Thousand Springs, Site 11 (N=1, SBMNH); Site 51 (N=2, LACM); Site 119 (N=1, UCLA); "Indian Shell Mound" (N=10, LACM); "2 mounds on the summit of San Nicolas Island" (N=7, UCLA); No site specified (N=8, LOWM; N=3, UCLA; N=1, UCSB).

SCll Archaeological Sample (SCIII; N=1). Los Angeles Co., San Clemente Island: Site 43C (N=1, UCLA-AC).

BOOK REVIEW

Botany for Gardeners: An Introduction and Guide. Brian Capon. Portland, Oregon: Timber Press. 1990. Pp. 220. $29.95. ISBN 0–88192–163–7.

In this small book, written to further the botanical knowledge and understanding of gardeners, the essentials of all aspects of general botany are lucidly and accurately presented, using a minimum of technical terminology. The clarity of presentation is further enhanced by accurate, aesthetically pleasing line drawings, executed by the author himself. In addition, there is a generous selection of color plates that, although very instructive, all but jump off the page in their beauty.

One may wonder why a book with gardeners as a targeted readership should be reviewed in the *Journal of Ethnobiology*. The reason, to me at least, is obvious. Many ethnobiologists, indeed many ethnobotanists, have had limited training in basic botany, with the result that their botanical knowledge is flawed, sometimes inaccurate, and often sadly deficient. (In all fairness, many ethnobiologists who are well trained in biology have had limited training in anthropology and archaeology.) I recommend this book designed for gardeners to those ethnobiologists with limited background in botany as a means of obtaining an integrated picture of general botany, and as a first step in developing the language and concepts to be conversant in the subject.

Although it is not possible to point out all the areas of botany surveyed in this slender volume, I would like to mention these: the nature of plant growth; organization of roots, stems, and leaves; adaptations to internal and external forces; environmental control of growth and development; plant water relations and mineral uptake; the morphology and physiology of reproduction; inheritance; etc. An organizational feature of the book which I like and which I think will be most useful to a novice is the Glossary–Index. If, for example, you would like to know the difference between a bulb, corm, and a rhizome, turn to the Glossary–Index to learn that a bulb is "a short, flattened stem bearing fleshy, food–storage leaves, pp. 108, 137, 197;" a corm is "a short, swollen underground stem in which food is stored, pp. 109, 197;" and a rhizome is "an underground, horizontal stem, pp. 101, 110, 197." The definitions may serve your immediate purposes very well in which case there is no need to turn to the pages referred to for additional discussion.

I reiterate that although this book will be of limited value to ethnobiologists with a fair to extensive background in botany, I recommend it to those who have picked up their knowledge of botany in a piece–meal fashion.

—W.V.

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AVAILABILITY AND NUTRITIONAL VALUE OF *CYMOPTERUS* (APIACEAE) ROOTS IN THE COLORADO STEPPE

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ABSTRACT.—The density, collection rate, dry weight, and nutritional content of *Cymopterus montanus* and *C. acaulis* (Apiaceae) roots were determined. The density of each species at three landscape positions in steppe vegetation was usually less than one plant/m^2. The exception was 3.8 *C. acaulis* plants/m^2 on ridgetops. In areas where *Cymopterus* plants were common the maximum density, dry weight, and root collection rates were 27 plants/m^2, 5.1–6.6 g/root, and 0.9 roots per minute for *C. montanus* and 12 plants/m^2, 1.5–1.6 g/root, and 0.7 roots per minute for *C. acaulis*. In both species the roots had 43–45% of dry weight as fiber, 20–25% digestible carbohydrate, and 1–2% nitrogen. Sucrose was the main sugar in both species. The total sugar content of dry, skin-free roots was 11.7% of dry weight for *C. montanus* and 4.4% for *C. acaulis*. The sugar contents of *Cymopterus* roots, sugar beets and roots of several other Great Plains species were compared. Ecological aspects and the potential cultivation of *Cymopterus* species are also discussed.

RESUMEN.—Se determinó la densidad, tasa de recolección, peso seco y valor nutritivo de los raices de *Cymopterus montanus* y *C. acaulis*. Las densidades promedio para ambas especies fueron de menos de una planta/m^2 en todas las areas de praderas no perturbadas excepto en las cimas de lomados donde la densidad de *C. acaulis* fue de 3.8 plantas/m^2. En áreas donde las plantas de *Cymopterus* eran abundantes las densidad máxima, el peso seco y la tasa de recolección fueron de 27 plantas/m^2, 5.1–6.6 g/tubérculo y 0.9 tubérculos por minuto para *C. montanus* y de 12 plantas/m^2, 1.5–1.6 g/tubérculos y 0.7 tubérculos por minuto para *C. acaulis*. Estas especies, en terminos del peso seco, contenían 43–45% de fibre, 20–25% de carbohidratos y 1–2% de nitrógeno. El azucar más común en ambas especies fue la sacarosa. El contenido total de azúcares en los tubérculos sin cáscara fue de 11.7% en *C. montanus* y 4.4% en el caso de *C. acaulis*. El contenido en azúcares fue comparado con el de la remolacha azucarera y el de otras especies nativas. Se discuten tambien algunos aspectos ecológicos y la posibilildad de cultivar *Cymopterus*.

RESUME.—La densité, le taux de collection, le poids sec et la valeur nutritive des racines de *C. acaulis* et *C. montanus* ont été détermines. La dénsite de chaque espéce a trois differentes zones de la steppe de végétation est habituellement moins d'une plante par m^2. L'exception est 3.8 plantes/m^2 sur la cime des collines dans les zones oú les plantes de *C. acaulis* est répandues. Dans les lieux ou l'espèce *Cymopterus* est répandue, la densite maximale, les poids sec et le taux de collection des racines etaient de 27 plantes/m^2, 5.1–6.6 g/racine, et 0.9 g/minute pour

C. montanus et 12 plantes/m^2, 1.5–1.6 g/racine, et 0.7 g/minute pour *C. acaulis*. Chez les deux espèces les racines contenaient 43–45% de leur poids sec en fibres, 20–25% en hydrates de carbone digestible et 1–2% d'azote. Les racines ont été analysées pour quatre sucres, le sucrose s'est avéré le plus abondant chez les deux espèces. La teneur en sucre des racines epluchees a ete 11.7% dupoids sec pour *C. montanus* et 4.4% pour *C. acaulis*. Une comparaison du contenu en sucre des racines de *Cymopterus*, de la betterave a sucre et de plusieurs autres especes des hautes plaines a été effectuée. Les aspects éologiques et le potentiel de culture du *Cymopterus* ont été discutés.

INTRODUCTION

The best known root crops in the Apiaceae are carrots (*Daucus carota* L.) and parsnips (*Pastinaca sativa* L.), native to Europe, and *Arracacia xanthorrhiza* Bancroft from South America. Although no North American species in the Apiaceae have yet been domesticated, roots from plants in the genus *Lomatium* have been important staples for many Indian groups in Western Canada and North America. Roots from plants in the genus *Perideridia* are still eaten by Indians in the interior parts of the Pacific states (French 1971). This paper examines edible roots of two *Cymopterus* species that could have been a seasonally important food source to indigenous groups in the shortgrass steppe region of the Great Plains: *Cymopterus acaulis* (Pursh) Raf. and *Cymopterus montanus* (Nutt.) T. & G.

Most of the 48 species in the genus *Cymopterus* occur in mountain areas and have small geographical distributions (Hartman, pers. comm. 1990). By comparison, the geographical ranges of *C. acaulis*, *C. macrorhizus* Buckl. and *C. montanus*, the only three *Cymopterus* species reported in the Flora of the Great Plains (McGregor 1986), are much greater. Since wider ranges imply greater familiarity and availability to indigenous groups, the utilization of Great Plains *Cymopterus* species was probably greater than that of species that occur only in isolated mountain areas.

Spanish and English speaking persons have attributed vernacular names to *Cymopterus* plants based on plant names familiar to them. For example, common names for *Cymopterus* listed by Harrington (1967) include biscuit root, corkwing, wafer parsnip, and wild celery. The Spanish name "camote" was reported for *C. montanus* by Hedrick (1972), but this name is more commonly applied to *Ipomoea batatas* (L.) Lam., the sweet potato. In like fashion, *Cymopterus* roots have been called prairie turnips, a name more often used for *Psoralea esculenta* Pursh (Kindscher 1987), even though neither *Psoralea* nor *Cymopterus* are in the Brassicaceae, the family of *Brassica rapa* L., the garden turnip. Currently, the common names for *Cymopterus* are seldom used or known. In contrast to English and Spanish common names, Indian names for *Cymopterus* (none were found) would be of greater significance since such names would be from people that lived off the land for food, fiber and medicine.

The few ethnobotanical accounts of *Cymopterus* species are from Indian groups in the western and southwestern United States. These accounts are qualitative, brief, and usually refer to edible roots and/or shoots. Ten *Cymopterus* species reported by Harrington (1967), Havard (1895), Hedrick (1972), and Yanovsky (1936)

to have edible greens and/or roots are: *C. acaulis, C. bulbosus* A. Nelson, *C. globosus* (S. Wats.) S. Wats., *C. glomeratus* CD, *C. longipes* S. Wats., *C. montanus, C. newberryi* (S. Wats.) M.E. Jones, *C. purpurascens* (A. Gray) M.E. Jones, *C. purpureus* S. Wats., and *C. fendleri* A. Gray. In Hedrick (1972) Sturtevant described the roots of *C. montanus* as "spindly-shaped, parsnip-like but much softer, sweeter and more tender than the parsnip." *Cymopterus fendleri* roots were reported by Yanovsky as a condiment for meat, by Hedrick as a flavoring of mutton, and by Havard as a condiment "with a pleasant anisate volatile oil ... used to flavor meats and make bitters ..." Morton (1963) indicated that *Cymopterus* roots were best in early spring and when boiled. Presumably in reference to root size and quality, *C. globosus, C. glomeratus,* and *C. montanus* have been identified as the best-known esculents in the genus (Havard 1895). Other accounts report that photosensitization can occur in poultry from ingestion of *C. watsonii* or *C. longipes* leaves and seeds (Egyed and Williams 1977; Vankampe *et al.* 1969). Stermitz *et al.* (1975) identified furocoumarins as a photosensitizing chemical in *C. watsonii.* Finally, insecticidal properties have been attributed to a boiled water extract of *Cymopterus* roots by Sweet (1976).

This study was undertaken to determine the collection rates, field densities, and nutritional value of *C. montanus* and *C. acaulis* roots (Fig. 1) in the Northern shortgrass steppe region of the United States. These species were selected because of reports of their utilization by indigenous groups and, in the case of *C. montanus,* because it is reported as one of "best known esculents" in the genus (Hedrick 1972).

FIG. 1.—*Cymopterus acaulis* (left) and *C. montanus* (right) excavated in northeastern Colorado on May 7, 1989.

SITE DESCRIPTION

Field work was conducted during the spring of 1988 and 1989 at the Central Plains Experimental Range (CPER), an area with native shortgrass steppe vegetation that is administered by the USDA Agricultural Research Service. The CPER is located 8 km north of Nunn, CO (latitude 40° 49 N, longitude 104° 46 W) at 1,650 m elevation. Mean annual precipitation from 1969-1988 was 322 mm (standard deviation of 74 mm), but approximately 80% of annual precipitation occurs from April to September.

To characterize soil conditions, soil samples were collected from three locations where *C. montanus* plants were abundant. At each location three soil subsamples were collected from around *C. montanus* roots at a depth of 5-15 cm. Subsamples were combined to a single sample per location and were analyzed at the Colorado State University soil testing laboratory (Workman *et al.* 1988). The analyses indicated that all three locations had sandy clay loam soil. The ranges in soil properties at the three areas were: pH 6.4-7.2, organic matter 1.6-2.1%, N 6-9 ppm, P 1-7 ppm, K 171-238 ppm, Zn 0.2-0.3 ppm, Fe 5.5-11.5 ppm, Mn 6.0-12.8 ppm and Cu 0.7-1.0 ppm.

MATERIALS AND METHODS

Field densities of *C. montanus* and *C. acaulis* plants were estimated at nine undisturbed steppe locations in late April 1988 and at three disturbed steppe locations in early May 1989. The undisturbed locations were three ridgetop, three midslope, and three toeslope or lowland positions. Disturbed locations, selected on the basis of abundant *C. montanus* plants, were adjacent to a corral, along a road, and by a fence. At each location all *C. acaulis* and *C. montanus* plants in 50 randomly placed 0.25 m^2 quadrats were tallied. To estimate maximum field densities the five quadrats from the disturbed sites with the highest tallies of *C. montanus* were averaged. Since *C. acaulis* was uncommon in disturbed sites, the maximum field density for this species was the average density of the five quadrats with the highest densities from undisturbed sites.

In 1988 one *Cymopterus* root in or near every fifth quadrat was excavated until 41 *C. montanus* and 10 *C. acaulis* roots were collected. Each root was washed, air dried for 24 hours and weighed. Roots were then cut open, oven dried at 50°C for 7 days and reweighed with and without the less palatable root skins. Eight samples of dry *C. montanus* tissue (five roots each) and two samples of *C. acaulis* tissue (five roots each) were analyzed at Colorado State University for nitrogen, fiber, and digestible carbohydrate. Nitrogen extraction used the methods of Nelson and Sommers (1980). The fiber analyses procedure of Waldren (1971) identified neutral detergent fibers such as hemicellulose, cellulose, and lignin. The carbohydrate values were non-structural carbohydrates (Smith *et al.* 1964) that included sugars, dextrin, starch, and fructusans. Fiber and carbohydrates values were expressed as percent dry weight.

Root collection rates for both *Cymopterus* species were determined at the three disturbed sites by excavating as many roots as possible during 15 minutes. The collection pace was steady, not hurried, as roots were removed from the soil by digging with a sharpened stick. A stick is an implement similar to that available to indigenous persons, e.g. pronghorn antelope tine. From the excavated plants four *C. montanus* and three *C. acaulis* roots were selected at random and analyzed for individual sugar contents at the USDA/ARS Crops Research Laboratory in Ft. Collins using their standard, but unpublished analytical technique (Susan Martin, pers. comm. 1990). This technique involved peeling each root and hand-grating the skin-free portion to obtain a fine "sawdust" or brei. To about 2 g brei, glass-distilled water was added at a ratio of about 1:6 (w/w) brei:water; the exact weights of brei and water were recorded. The brei-water mixture was homogenized for 30 seconds (Brinkmann UltraTurrax), swirled to wash down container walls, and homogenized another 30 seconds. The mixture was filtered successively through Whatman No. 1, a 1.2μm membrane filter, and a 0.45μm membrane filter. Samples (20μL aliquots) were analyzed by HPLC on an ion exchange column in the calcium form (Waters Sugar Pak I), held at 85°C and eluted by 0.2mM calcium EDTA. Eluted components were detected by refractive index and quantified by electronic integration. The HPLC system was standardized daily with a series of standards that incorporated glucose, fructose, sucrose, and raffinose. Roots not selected for sugar analyses were weighed fresh, oven dried at 50°C for 7 days and weighed dry to estimate the water content of fresh roots.

Voucher specimens were made for *C. montanus* (*Hazlett 4651,* CS) and *C. acaulis* (*Hazlett 4652,* CS). Statistical differences between means for field densities, dry weights, and chemical contents were determined by t-tests.

RESULTS

At all three landscape positions in undisturbed steppe the density of *C. montanus* was ‹1 plant/m^2 (Table 1). The density of *C. acaulis* was also ‹1 plant/m^2 at toeslope and midslope positions, but was 3.8 plants/m^2 on ridgetops, significantly higher ($P < 0.05$) than at other landscape positions for this species and significantly higher than *C. montanus* at any location. Because disturbed sites were selected on the basis of abundant *Cymopterus* plants, the densities of *C. montanus* plants increased to a mean of 2.1 plants/m^2 in disturbed areas. The maximum density at disturbed sites was 39 plants/m^2 for *C. montanus*. The maximum density for *C. acaulis* occurred in undisturbed steppe and was 17 plants/m^2. All tallied individuals were sprouts from perennial roots and no juvenile plants of either species were encountered.

The mean dry weight of *C. montanus* roots, including skin, increased from 5.1 g/plant at undisturbed to 6.6 g/plant at disturbed sites. At both locations these values were significantly greater ($P < 0.05$) than the 1.5-1.6 g mean dry weight of *C. acaulis* roots from undisturbed and disturbed sites. For *C. montanus* and *C. acaulis* roots, the water content of fresh roots, including the skin, was 61% and 36% respectively. For individual roots the weight of the skin was 30% of total dry weight for *C. montanus* and, due to less root mass, 41% of total dry weight for *C. acaulis*.

TABLE 1.—Means and ranges in dry weight and densities of *Cymopterus montanus* and *C. acaulis* roots at different topopositions in native or "undisturbed" steppe and at disturbed steppe locations.

	Cymopterus montanus		*Cymopterus acaulis*	
	Mean	Range	Mean	Range
Dry wt (% of fresh wt)	38.5	—	64	—
Dry wt/root (g)				
—Undisturbed*	(27) 5.1	0.6–8.9	(10) 1.6	0.2–2.9
—Disturbed*	(40) 6.6	0.9–8.2	(33) 1.5	0.1–2.6
Density: Undisturbed steppe (plants/m^2)				
—3 Ridgetops*	0.4	0.0–0.6	3.8	0.3–7.6
—3 Midslopes	0.7	0.6–0.8	0.4	0.3–0.5
—3 Toeslopes	0.4	0.0–1.1	0.9	0.0–2.6
Density: Disturbed sites (plants/m^2)				
—All 3 areas*	2.1	1.8–2.4	1.0	0.5–1.4
—Maximum densities*	27	12–39	12	10–17

*Differences between means are significant ($P < 0.05$).
Values in parentheses are the number of samples.

Since the skin portion of *Cymopterus* roots is not very palatable, only the skin-free, white root tissue was used in calculations of food availability to humans. In undisturbed, randomly sampled steppe vegetation the amount of white root tissue was 1.4-2.5 g/m^2 for *C. montanus* and 0.7 g/m^2 for *C. acaulis*. However, based on mean root dry weights and mean maximum field densities in disturbed areas the availability of white root tissue was as high as 125 g/m^2 for *C. montanus* and 11 g/m^2 for *C. acaulis*. The collection rate for *C. montanus* at disturbed locations was 11-15 roots per 15 minutes (0.9 roots per minute). For *C. acaulis* at the same locations the collection rate was 10-12 roots per 15 minutes (0.7 roots per minute). Therefore, in areas where *C. montanus* is abundant, as much as 250 g of white, edible root tissue can be gathered in an hour.

Chemical analyses of plant tissue indicated that skin-free *C. acaulis* roots had a significantly higher nitrogen content than *C. montanus* (Table 2). However, *C. montanus* had significantly higher ($P < 0.05$) glucose and sucrose contents than *C. acaulis*. Total sugar content on a fresh weight basis was 4.5% for *C. montanus* and 2.8% for *C. acaulis*. On a dry weight basis the total sugar content was 11.7% for *C. montanus* and 4.4% for *C. acaulis* (Table 2). For both species sucrose was the most abundant sugar, constituting at least 88% of total sugar content. The average caloric content of sugars per 100 g of dry tissue, using the sucrose value of 3.9 calories/g of sugar, was 0.45 Cal/g for *C. montanus* and 0.17 Cal/g for *C. acaulis*.

TABLE 2.—Means and ranges in fiber, nitrogen, carbohydrate and sugars composition for naturally occurring *Cymopterus montanus* and *Cymopterus acaulis* roots from northeastern Colorado.

% of dry wt.	*Cymopterus montanus* Mean	Range	*Cymopterus acaulis* Mean	Range
Fiber[a]	44.6	32–54	42.8	36–49
Nitrogen[a]	1.0	0.7–1.2	1.6*	1.3–1.9
Carbohydrates[a]	24.4	18–29	20.3	16–25
Sugars:[aa]				
Raffinose	0.05	0–0.11	0.02	0.01–0.04
Glucose	0.08	0.04–0.16	0.03*	0.02–0.04
Fructose	0.18	0.10–0.25	0.07	0.05–0.09
Sucrose	11.28	9.88–14.89	4.25*	3.92–4.80

[a] n = 8 for both species.

[aa] n = 4 for *C. montanus;* n = 3 for *C. acaulis.*

*Significant differences (P 0.05) between species.

DISCUSSION

Compared to sugar contents of underground tissues from other native Great Plains plant species the 11.7% value for *C. montanus* was more than twice as high as the 5.6% sugar content reported for *Psoralea esculenta* (Kaldy *et al.* 1980) or the 4.4% sugar content reported herein for *C. acaulis.* On the other hand, the 11.7% sugar content in *C. montanus* was less than the 16.2% reported for *Perideridia gairdneri* (Hook. & Arn.) Mathias or 51.6% for *Helianthus tuberosus* L. (Kaldy *et al.* 1980). Except for *H. tuberosus,* all these values are less than a 35% dry weight sugar content reported for early European cultivars of white sugar beets, *Beta vulgaris* L. (Coons 1936). In nearly 200 years of selection the sugar content of *B. vulgaris* cultivars has been increased to approximately 80% of dry and near 16% of fresh weight. Cultivar selections for high sugar contents among native Great Plains plants would start from a much higher initial sugar content for *H. tuberosus* and could conceivably double the sugar content of *Cymopterus* roots.

In contrast to studies that document only nutritional contents of wild collected roots (Kaldy *et al.* 1980; King and Gershoff 1987) this study also quantified densities and collection rates of *Cymopterus* roots from naturally occurring populations. A maximum field density of 125 g/m^2 of edible *C. montanus* tissue is of interest for several reasons. First, this value is similar to 100 g/m^2, an average value for aboveground annual net primary production in steppe vegetation (Sims and Singh 1978). Therefore, in some steppe locations the availability of edible *Cymopterus* roots is greater than average annual aboveground biomass production. Another implication of high concentrations of *Cymopterus* roots is credence

to reports that these roots, relatively high sugar, were utilized by indigenous people. Finally, when native plants occur naturally in dense stands they have a greater possibility of adapting to dense stands in crops or gardens.

Although *Cymopterus* roots are a concentrated source of carbohydrate energy, only once was a *Cymopterus* root seen that was excavated; it apparently had been removed and eaten by a rodent. Furthermore, few roots showed any sign of damage by insects or pathogens. Since minimal damage occurs to *Cymopterus* roots in dense, naturally occurring populations, an important implication is that these plants could also be relatively insect and pathogen free in the aggregated condition required for gardens or crops. The absence of insect damage on any of the excavated or peeled roots also accented the observation of insecticidal properties for *Cymopterus* reported by Sweet (1976). Perhaps insect-repelling chemicals occur in *Cymopterus* roots. If so, they may be concentrated in the skin, another reason to remove the skin before consumption. In addition, allelopathic chemicals may be dispersed from roots into the soil, such as when *Cymopterus* plants die, and afford a degree of protection from herbivores to this root or to roots of neighboring plant species. Of special interest in this regard is the possibility that larva of *Phyllophaga* beetles, a pest of native rangeland grasses (Haws 1982), may avoid areas where *Cymopterus* roots occur or have occurred.

Available information on the life-history of *C. montanus* and *C. acaulis* indicates that *Cymopterus* plants are the first steppe species in northeastern Colorado to flower each spring, in March and April, and are the first perennial plants to disperse fruits (Dickinson and Dodd 1976). This study has further determined that although these two *Cymopterus* species often occur together, there are habitats where one or the other is more abundant: *C. acaulis* is more abundant on ridgetops and *C. montanus* is more abundant in areas of human disturbance. Since there was exposed shale on ridgetops, deeper water penetration associated with rocky soil may help explain greater ridgetop densities of *C. acaulis*. Greater water availability related to the absence of competing plants may also contribute to the success of *C. montanus* in disturbed areas. Although soil water availability may favor plant establishment on ridgetops and in disturbed habitats, the timing and extent of water availability probably differ between these locations. Also, seed dispersal differentiation may occur because the corky, winged *C. montanus* fruits appear to be more easily carried by rainwater than are fruits of *C. acaulis*. Finally, the fact that *C.montanus* roots store nearly four times more carbohydrates than *C. acaulis* roots may help explain the difference in habitat preference between these two species.

Indigenous persons usually preferred fruits and seeds as a food resource over underground storage organs such as *Cymopterus* roots (Bates 1985). However, in steppe vegetation fruits and seeds are scarce early in the year, the time when *Cymopterus* roots are most available. During the spring *Cymopterus* roots are probably the most abundant source of human food of any native steppe plant. Later in the year the roots are still there, but plants are difficult to locate because all aboveground tissue withers and dies. While other plant species with edible underground tissues occur in the shortgrass steppe, e.g. *Allium textile* A. Nels. & Macbr., *Glycyrrhiza lepidota* Pursh, *Liatris punctata* Hook. and *Psoralea tenuiflora*

Pursh, the density and concentration of food per unit area for each of these species alone or even combined is probably less than that of *C. montanus*.

CONCLUSIONS

This study has presented new information on the ecology and nutritional properties of two *Cymopterus* species native to the shortgrass steppe region of the Great Plains. Since these are native, edible plants it is important to document their nutritional value for people and to discuss their domestication potential. In terms of sugar content, *C. montanus* has a relatively high sugar content and may eventually be cultivated, perhaps as a xeric, home garden plant. Ecological characteristics of *C. montanus* plants that encourage domestication include natural occurrence in aggregated populations, low water requirements, food availability early in the spring, and a popular demand for native plant species. Obstacles to domestication include lack of knowledge on growth rates, life history, chemical composition, propagation techniques, and cultural acceptance. A next step in evaluating this species for human consumption is to test for possible toxic chemicals, such as those that occur in other *Cymopterus* species.

Finally, the collection rates of *Cymopterus* roots by indigenous persons probably did not exceed the values reported here. Since the incidence of disturbed steppe habitats, locations where *C. montanus* are most dense, have increased in the last century, the availability of *Cymopterus* roots as a wild-collected food source may be greater now than at any time in the past.

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USE AND NUTRITIONAL COMPOSITION OF SOME TRADITIONAL MOUNTAIN PIMA PLANT FOODS

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ABSTRACT.—Foods of plant origin traditionally consumed by the Mountain Pima of Chihuahua, Mexico, were analyzed for proximate and mineral content. Fruits and immature cladodes of *Opuntia robusta, O. durangensis,* and *O. macrorhiza;* fruits of *Arctostaphylos pungens, Arbutus xalapensis, Berberis pimana, Prunus persica, P. serotina* var. *virens,* and *P. gentryi;* roots of *Prionosciadium townsendii;* tubers of *Dahlia coccinea;* bulbs of *Hymenocallis pimana;* inflorescences of *Tillandsia erubescens;* and leaf bases and immature flowering stalks of *Agave shrevei* were analyzed for lipid, protein, fiber, ash, carbohydrate, Fe, Cu, Zn, Ca, and Mg. Mineral content was determined for fruits of *Solanum diphyllum* and for shoots of three native condiments, *Monarda austromontana, Hedeoma patens,* and *Teloxys ambrosioides.* We also describe native uses of these foods, as well as of *Physalis* spp., *Echinocereus* spp., *Mammillaria* spp., *Amaranthus* spp., *Chenopodium leptophyllum, Portulaca oleracea, Passiflora* spp., *Lonicera cerviculata, Yucca* spp., *Rhus trilobata, Pinus discolor, Cyperus esculentus, Allium* spp., *Begonia gracilis, Oxalis* spp., and *Capsicum annuum* var. *aviculare.*

RESUMEN.—Alimentos de origen vegetal traditionalmente usados por los pima montañés de Chihuahua, Mexico, se analisieron por sus contenidos próximos y minerales. Frutas y cladodes juveniles de *Opuntia robusta, O. durangensis,* y *O. macrorhiza; frutas de Arctostaphylos pungens, Arbutus xalapensis, Berberis pimana, Prunus persica, P. serotina* var. *virens,* y *P. gentryi;* raíces de *Prionosciadium townsendii;* tubérculos de *Dahlia coccinea;* bulbos de *Hymenocallis pimana;* inflorescencias de *Tillandsia erubescens;* bases de hojas y guiotes jóvenes de *Agave shrevei* se analysieron por grasa, proteína, fibra, ceniza, carbohidrato, Fe, Cu, Zn, Ca, y Mg. Composición mineral se determinó de las frutas de *Solanum diphyllum* y de tres condimentos indígenas, *Monarda austromontana, Hedeoma patens,* y *Teloxys ambrosioides.* Describimos también la utilisación traditional de estas comidas y de *Physalis* spp., *Echinocereus* spp., *Mammillaria* spp., *Amaranthus* spp., *Chenopodium leptophyllum, Portulaca oleracea, Passiflora* spp., *Lonicera cerviculata, Yucca* spp., *Rhus trilobata, Pinus discolor, Cyperus esculentus, Allium* spp., *Begonia gracilis, Oxalis* spp., y *Capsicum annuum* var. *aviculare.*

RESUME.—Quelques aliments d'origine plantale traditionamment consumées par les pima montagneux de Chihuahua, Méxique, se sont analyzés pour sa composition proximale et minerale. Les fruits et les cladodes juveniles d'*Opuntia robusta, O. durangensis,* et *O. macrorhiza;* les fruits d'*Arctostaphylos pungens, Arbutus xalapensis, Berberis pimana, Prunus persica, P. serotina* var. *virens,* et *P. gentryi;* les racines de *Prionosciadium townsendii;* les tubercules de *Dahlia coccinea;* les bulbes de *Hymenocallis pimana;* les inflorescences de *Tillandsia erubescens;* et les bases de feuilles et les tiges juveniles de l'inflorescence d'*Agave shrevei* se sont analyzés pour le gras, la proteine, la fibre, la cendre, les carbohydrates, Fe, Cu, Zn, Ca, et Mg. Le content mineral s'est determiné pour les fruits de *Solanum diphyllum,* et pour trois condiments traditionels, *Monarda austromontana, Hedeoma patens,* et *Teloxys ambrosioides.* Nous descrivons aussi l'utilisation traditionelle de ces aliments et celle de *Physalis* spp., *Echinocereus* spp., *Mammillaria* spp., *Amaranthus* spp., *Chenopodium leptophyllum, Portulaca oleracea, Passiflora* spp., *Lonicera cerviculata, Yucca* spp., *Rhus trilobata, Pinus discolor, Cyperus esculentus, Allium* spp., *Begonia gracilis, Oxalis* spp., et *Capsicum annuum* var. *aviculare.*

INTRODUCTION

The Mountain Pima utilize several noncultivated plants and animals for food, fiber, building materials, medicine, and several other uses. On a percent weight basis, noncultivated edible plants constitute only a small portion of the total diet, but their importance is far greater than this small percentage would suggest. Many of the wild plant foods represent important sources of vitamins and minerals, especially vitamins A and C. Such resources represent important sources of these nutrients for the neighboring Tarahumara (Connor *et al.* 1978, Cerqueira *et al.* 1979). Wild plants become extremely important during certain seasons of the year. Most of them are available in summer, when stores of the previous year's maize and bean harvests are running low.

Noncultivated resources may also take on an added importance during droughts and other crop failures. Dunnigan (1983) reported that use of noncultivated resources increases among the Mountain Pima during times of adversity, as has been demonstrated for other traditional peoples in other parts of the world (Grivetti 1979). Some of the people acknowledge this increased dependence on wild resources, while others deny that crop failures occurred in past years. Today, the Pima respond to crop failures by working as wage laborers and selling livestock, as well as by increasing their use of noncultivated resources. This, plus the availability of commercially produced food, has lessened the importance of non-cultivated resources under such circumstances but has not eliminated it (Dunnigan 1970). Some of the less-preferred plant resources, e.g. bulbs of *Hymenocallis pimana* Lafer. (Amaryllidaceae), played an important role in the past as famine foods (Laferrière 1989a).

The Mountain Pima live in the Sierra Madre Occidental in the region straddling the boundary between the States of Chihuahua and Sonora, Mexico. They are linguistically related to the Pima and Tohono O'odham (Papago) of Arizona and lowland Sonora. The people engage in animal husbandry and subsistence agriculture, raising cattle, goats, pigs, chickens, and turkeys, and planting maize,

beans, squash, potatoes, and other crops (Dunnigan 1970, 1983; Laferrière and Van Asdall 1991a). The predominant natural vegetation of the area is pine/oak forest. A few other species of trees are present in the vicinity. Madroño (*Arbutus xalapensis* H.B.K. and *A. arizonicus* (A. Gray) Sarg., Ericaceae) is common in forested areas, while ahuasiqui (*Prunus gentryi* Standl., Rosaceae), capulín (*P. serotina* Ehrh. ssp. *virens* (Woot. & Standl.) McVaugh var. *virens*), and palo prieto (*Ilex tolucana* Hemsl., Aquifoliaceae) are frequent along riverbanks. Sabino (*Cupressus arizonica* E. Greene, Cupressaceae) forms thick shaded stands in moister canyons, and there are a few small groves of haya (*Acer grandidentatum* Nutt., Aceraceae) near larger rivers.

Several of the wild plant foods utilized by the Mountain Pima have never been analyzed for nutritional content, and two have been described botanically only recently (Laferrière 1990a; Laferrière and Marroquín 1990). The present study was undertaken to ascertain the nutritional value of certain cultivated and non-cultivated plant foods. We analyzed several of the more important Mountain Pima plant foods for proximate and mineral composition. Some of the smaller, less important items were not included because of difficulty in obtaining sufficiently large quantities of material. Quelites, or wild edible greens, were not analyzed since several existing publications already describe their nutritional value (Bye 1981; Cerqueira *et al.* 1979; Connor *et al.* 1978; Franke 1985; Maytowitz and Matthews 1984). Sufficient quantities of naranjilla berries (*Solanum diphyllum* L., Solanaceae) were obtained for mineral but not proximate analysls.

METHODS AND MATERIALS

Ethnographic information was obtained by JEL through participant observation and by interviews with residents of Nabogame, Yepachi, and Las Varitas, Chihuahua. Fieldwork lasted a total of 13 months between October 1986 and November 1988. Samples for analysis were collected from the vicinity of Nabogame, Municipio Temósachi, Chihuahua, 28°30'N, 108°30'W, elevation 1800 meters. The site is located approximately 18 km northwest of the commercial center of Yepachi and 10 km east of the Sonoran frontier. This village should not be confused with the larger Tepehuan community of the same name farther south in Chihuahua.

Each sample represented a conglomerate of several individual plants from the same general vicinity. Most samples were sun-dried (Kuhnlein 1986) for shipment to Tucson. Leafy material was air-dried indoors, while tubers of kachana (*Dahlia coccinea* Cav., Asteraceae), leaves and flowering stalks of chugilla (*Agave shrevei* Gentry ssp. *matapensis* Gentry, Agavaceae), bulbs of *Hymenocallis pimana*, and fruits of *Arbutus xalapewsis* were transported fresh. Bulbs of *H. pimama* and leaf bases of *A. shrevei* were peeled before analysis. Fruits of *Prunus* spp. were pitted before drying, but those of other fruits were analyzed complete with seeds because this is how they are consumed. *Opuntia* fruits and cladodes (pads) were despined and washed in the Mountain Pima manner. Vouchers are on deposit at ARIZ and MEXU.

Upon arrival at the laboratory all items were weighed and frozen. They were then lyophilized, weighed, and ground into a powder using a blender and/or Wiley mill. The ground samples were placed in plastic bags and stored in a freezer until analyzed.

Samples were analyzed in triplicate. The logistical necessity of drying specimens for transport precluded accurate moisture figures for most of the samples. Protein, fat, and ash were determined by AOAC (1980) methods. Crude fiber was determined by the Acid Detergent Fiber method of Van Soest (1963). Carbohydrate content was calculated by subtracting from 100 the difference of moisture, fat, protein, and ash. The energy values were calculated by multiplying the grams of carbohydrate and protein by 4 kcal per gram and the fat by 9 kcal per gram (National Research Council, 1980). Minerals were determined by wet ashing using the AOAC (1980) method. Acid digested samples were quantitatively transferred and made up to a given volume. Minerals were run by flame atomic absorption spectrophotometry (Hitachi, 180–70). Mineral standards were prepared on a daily basis from certified atomic absorption standard solutions (Fisher Scientific, NJ). Linear regression of the standard curves were determined after running 10 unknown samples and had an accuracy of 5% within runs and 10% between runs. The magnesium and calcium samples were masked with a 1% lanthanum concentration (Deeming and Weber, 1977). Phosphorus was determined by the method of Koenig and Johnson (1942). All glassware was acid-washed in 50% HNO_3 and rinsed three times in distilled deionized water.

RESULTS AND DISCUSSION

Results of proximate analysis are given in Table 1 while results of mineral analyses are presented in Table 2. The results of our nutritional analyses agree in large part with previous studies, for those plants which have previously been analyzed. Values for the two cultivated species, squash and peaches, agree with values published by Gebhardt *et al.* (1984) and Haytowitz and Matthews (1984). Subterranean organs generally showed large amounts of carbohydrates, as did *Agave shrevei*. Fruits analyzed with seeds proved much higher in fiber than the pitted fruits of *Prunus* spp. The four taxa of *Opuntia* varied considerably in chemical content, although all were high in carbohydrate, fiber, calcium, and magnesium.

Cultivated crops.—Major cultivated crops include maize (*Zea mays* L., Poaceae), beans (*Phaseolus vulgaris* L., Fabaceae), squash (*Cucurbita pepo* L., Cucurbitaceae), potatoes (*Solanum tuberosum* L.), and peaches (*Prunus persica* L.) (Laferrière and Van Asdall 1991a). The Mountain Pima cut peeled, seeded squash into strips, wind the strips into coils and sun-dry them for winter use (Laferrière & Van Asdall 1991a). The Navajo and Tarahumara dry squash in a similar manner (Bennett and Zingg 1935; Vestal 1952).

The Mountain Pima use peaches both green and ripe. Green peaches are stewed with sugar or roasted in the fire to soften them. Green peaches are higher in fiber and lower in carbohydrate than ripe fruits (Table 1).

Table 1: Proximate composition of Mountain Pima food plants (percent, moisture-free basis)

SPECIES	PART	KCAL	PROTEIN	CARBOHYDRATE	LIPID	FIBER	ASH
Agave shrevei matapensis	flower stalk	295	4.68	67.44	0.74	21.71	5.43
	leaf base	243	2.73	56.89	0.54	19.61	20.23
Arbutus xalapensis	fruit	276	4.15	58.17	3.00	32.72	1.96
Arctostaphylos pungens	fruit	222	2.67	43.87	4.00	48.31	1.15
Berberis pimana	fruit	329	9.70	58.18	6.35	22.35	3.42
Cucurbita pepo	mesocarp	303	4.86	68.51	1.02	16.38	9.23
Dahlia coccinea	tuber	258	16.39	47.81	0.15	31.28	4.37
Hymenocallis pimana	bulb	389	14.29	77.49	2.40	3.16	2.66
Jaltomata procumbens	fruit	224	12.75	36.67	2.87	43.95	3.76
Opuntia durangensis (duraznillo blanco)	cladode	289	6.11	61.19	2.15	16.33	14.22
	fruit	260	3.34	57.78	1.79	25.46	11.63
Opuntia cf. macrorhiza	cladode	357	2.16	86.17	0.45	7.77	3.45
	fruit	291	5.32	54.56	5.71	30.17	4.24
Opuntia cf. robusta (temporal)	cladode	263	13.84	48.50	1.53	17.43	18.70
	fruit	317	4.59	68.30	2.87	17.76	6.48
Opuntia cf. robusta (noviembrena)	fruit	284	2.61	61.67	3.02	26.51	6.19
Prionosciadium townsendii	root	346	5.83	76.58	1.79	11.86	3.94
Prunus gentryi gentryi	pericarp	324	3.98	76.73	0.13	12.05	7.11
Prunus persica	mature fruit	368	6.18	85.23	0.29	4.77	3.53
	green fruit	311	7.87	64.23	2.56	17.16	8.18
Prunus serotina virens	mesocarp	203	3.11	46.42	0.51	27.86	22.1
Tillandsia erubescens	inflorescence	316	8.75	66.40	1.70	13.80	9.35

Table 2: Mineral composition of Mountain Pima plant foods (ppm, moisture-free basis)

SPECIES	PART	Fe	Cu	Zn	Ca	M
Agave shrevei matapensis	flower stalk	56	3	19	10618	3826
	leaf base	54	10	29	52476	18392
Arbutus xalapensis	fruit	37	6	106	3713	899
Arctostaphylos pungens	fruit	13	8	9	1809	392
Berberis pimana	fruit	51	20	15	2337	1154
Cucurbita pepo	mesocarp	87	7	8	3020	2357
Dahlia coccinea	tuber	41	7	9	3756	1513
Hedeoma patens	shoot	485	8	28	12530	991
Hymenocallis pimana	bulb	34	5	20	3724	912
Jaltomata procumbens	fruit	33	8	21	1171	2412
Monarda austromontana	shoot	821	12	49	13039	4313
Opuntia durangensis (duraznillo blanco)	cladode	96	2	8	24222	19385
	fruit	214	18	24	23543	6392
Opuntia cf. macrorhiza	cladode	85	13	56	15414	9172
	fruit	161	8	10	6078	4290
Opuntia cf. robusta (temporal)	cladode	156	5	161	12350	8395
	fruit	117	10	15	4543	3613
Opuntia cf. robusta (noviembrena)	fruit	47	76	51	3426	1888
Prionosciadium townsendii	root	174	10	20	6442	2899
Prunus gentryi gentryi	pericarp	44	58	102	2119	946
Prunus persica	mature fruit	45	2	5	395	612
	green fruit	188	10	7	1262	1109
Prunus serotina virens	pericarp	45	6	8	1617	795
Solanum diphyllum	fruit	54	8	8	1080	1383
Teloxys ambrosioides	shoot	127	9	9	18929	14182
Tillandsia erubescens	inflorescence	137	2	32	15528	7697

Cacti.—Fruits and cladodes (pads) of *Opuntia* spp. (Cactaceae) have been widely utilized as food sources in much of the New World (Meyer and McLaughlin 1981; Russell and Felker 1987). Six folk taxa of prickly pear (*Opuntia* spp.) are recognized by the Pima of Nabogame (Fig. 1). These include the cultivated nopal de Castilla (*O. ficus-indica* (L.) Miller) and five wild taxa, i.e. nopal temporal (purple-fruited individuals of *O.* cf. *robusta* Wendl.), tuna noviembreña (red-fruited *O.* cf. *robusta*), nopal de zorra (*O.* cf. *macrorhiza* Engelm.), duraznillo blanco (yellow-fruited *O. durangensis* Britton & Rose), and duraznillo colorado (red-fruited *O. durangensis*).

The cladodes are especially important during the spring dry season since they are one of the first noncultivated resources to become available in the year. Cladodes of all six taxa are used in much the same manner. Nopal temporal is the most important, producing the largest cladodes and growing abundantly in virtually any nonplowed site. Tuna noviembreña is very similar, but has red rather than purple fruits which mature in October or November rather than August. Nopal de zorra is a small recumbent species producing narrow obconical fruits. The immature cladodes of both these species have an orange tint, especially toward the distal edge. Duraznillo is strikingly different in general appearance, being a darker shade of green and having smaller cladodes bearing shorter but more numerous spines while lacking the reddish tint. Nopal de Castilla is planted in a few kitchen gardens, and is valued for its large size and absence of spines.

FIG. 1.—Fruits of (l–r) tuna temporal (*Opuntia* cf. *robusta*), duraznillo blanco (*O. durangensis*), and tuna de zorra (*O.* cf. *macrorhiza*).

The Mountain Pima harvest the cladodes by holding a bucket underneath and cutting the base, allowing the cladode to fall in. They remove the spines and glochids on a rock at the bank of the brook and scrape away the areoles with a knife, spoon, or other metal object. The small glochids can cause inflammation

of the mouth if ingested (Georgi *et al.* 1982). Scraping is done first toward the distal end of the cladode, removing the majority of the spines, then reversing the scraping direction to remove the remainder. Water is periodically flushed over the cladode to clean away the loosened spines. A few of the cladodes are eaten raw, but the majority are chopped and fried in lard with onions and/or garlic. The cladodes are cut by holding them vertically in the left hand and making parallel slits downward toward the base, followed by further slits perpendicular to the first.

The Mountain Pima consume fruits or ''tunas'' of all local taxa of *Opuntia*. The fruits ripen in August and September except for those of tuna noviembreña which mature in October or November. Those of nopal de Castilla and nopal temporal are preferred, since they are much larger than the fruits of the other two species. The spines of both species are removed using cuts parallel to and just below the skin. Fruits of nopal de zorra are too juicy for this method, since the interior of the fruit consists primarily of mucilaginous endocarp; hence the juicy area is generally scraped out with a knife. The fruits of duraznillo are the smallest and driest of the four species in the community. These are seldom utilized, but are treated like those of nopal temporal.

All cladodes in our study proved higher in carbohydrate and lower in ash and protein than the values reported for cladodes of the cultivated *O. ficus-indica* (Feitosa–Teles 1977; Feitosa–Teles *et al.* 1984). Cladode composition can vary depending on degree of maturity; protein, fiber contents tend to decrease on a percent weight basis as the cladode matures, while starch, lipid, carotene and free sugar increase (Retamal *et al.* 1987; Rodriguez–Felix and Cantwell 1988).

The cladodes have a very high calcium content, although this may vary somewhat according to soil content (Nobel *et al.* 1987; Gonzalez 1989). The high calcium values of *Opuntia* cladodes are largely due to the plants' accumulation of insoluble calcium oxalate. Up to 85% of the calcium in some cacti may be in the form of calcium oxalate (Trachtenberg and Mayer 1982b). This may constitute as much as 21% of the dry weight of the cladodes (Rodríguez–Mejía *et al.* 1985). *Opuntia plumbea* Rose contains 1.5% oxalate content by fresh weight (Justice 1985). This makes much of the calcium unavailable for human consumption. The calcium present in the cladodes shifts on a diurnal basis from being bound as calcium oxalate to being bound to the mucilage (Trachtenberg and Mayer 1982a,b). This is as a result of the pH cycles characteristic of Crassulacean Acid Metabolism common to most cacti (Trachtenberg and Mayer 1982a,b). Hence the amount of calcium available for digestion may vary accoring to the time of day.

The quantity of carbohydrate available for utilization may be also somewhat lower than our figures indicate. Some of the mucilage which constitutes a significant proportion of the carbohydrate fraction is digestible, but a sizeable fraction is not. The proportion of digestible matter varies from one species of *Opuntia* to another (McGarvie and Parolis 1979b, 1981). The hypoglycemic effect reported for *Opuntia* cladodes (Ibañez–Camacho *et al.* 1983; Frati–Munari *et al.* 1987) may be due to an inhibition of the absorption of simple carbohydrates rather than any direct effect on insulin production (Frati–Munari *et al.* 1988).

Fruits of cholla *(Mammillaria barbata* Engelm., *M.* cf. *sonorensis* Craig, *Echinocereus stoloniferus* W.T. Marshall ssp. *tayopensis* (Marsh.) N.P. Taylor, *E. sheeri*

(Salm-Dyck) Rumpler var. *sheeri,* and *E. polyacanthus* Engelm. var. *polyacanthus,* all Cactaceae) are also eaten raw when mature in late summer, but are small and comparatively rare. *Echinocereus* fruits possess sharp spines which adversely affect their utilization. Fruits of other species of *Mammillaria* and *Echinocereus* have been reported consumed by the Navajo, Seri, and Tarahumara (Elmore 1943; Vestal 1952; Felger and Moser 1985), and by the Pima of Arizona (Curtin 1949). Stems of several species of *Mammillaria* have also consumed as food (Robbins *et al.* 1916; Vestal 1952). Some of the latex-containing species, however, have been used as hallucinogens (Bye 1979). Fruits of *E. coccineus* Engelm. are reportedly poisonous and used by the Navajo as a heart stimulant (Elmore 1943). Stems of certain species of *Echinocereus* have been used as hallucinogens (Bye 1979; Ferrigni *et al.* 1982), although stems of other species have been used to make candy (Nobel 1988).

Agave.—Chugilla *(Agave shrevei)* supplies the Mountain Pima with two food items plus a potent piscicide. Immature flowering stalks or "guiotes" are harvested in May and June. They are roasted in the fire, peeled, and chewed upon to extract the juicy interior. The fibrous material which constitutes a large fraction of the stalk material is then spit out.

Leaves of *Agave shrevei* contain several compounds which inhibit their utilization as food sources. These leaves are used raw as fish stupification plants by the Mountain Pima and the Tarahumara (Bye *et al.* 1975; Dunnigan 1970; Bennett and Zingg 1935; Gentry 1982). The plants contain several different saponins, primarily hecogonin and manogenin, but no flavones or tannins (Hegnauer 1963, 1986; List and Horhammer 1972; Dominguez *et al.* 1960). The saponins present in the leaves and rootstocks make these tissues useful for washing clothes (Sheldon 1980). Extracts from *Agave* sap affect the nervous system and produce diarrhea when injected into laboratory animals (Jones *et al.* 1932). Sap from *Agave* leaves also kills snails and inhibits the growth of fungi (Shoeb *et al.* 1986; de Cassia-Salomao and Purchio 1982) and has been used as an antiseptic (Davidson and Ortiz de Montellano 1983). An unidentified compound in many species, including *A. shrevei,* causes dermatitis (Gentry 1982).

Leaves of various species of *Agave* have, however, commonly been roasted and consumed as food throughout the range of the genus (Gentry 1982; Castetter *et al.* 1938; Ebeling 1986; Mitich 1976). The Mountain Pima use the white leaf bases of *A. shrevei* by roasting them in large pits, peeling them, and eating them (Fig. 7). The roasting is sufficient to destroy most of the saponins, leaving a rather sweet, juicy but fibrous mass. The roasting pits are rather large and can often still be seen years after their utilization. Kovacevic *et al.* (1963) reported somewhat higher protein (3.64% dry weight) and lower ash (5.76%) values from cooked leaf mesoderm of *A. americana* L. Roasting may alter the digestibility of some nutrients as well as lower the saponin content.

Other fruits.—The Mountain Pima also utilize several other wild fruits, although none is common enough to make a significant contribution to the diet. The most important of these is ahuasiqui *(Prunus gentryi),* which grows along the banks of some of the larger creeks. The fruits mature in June and July. Two folk species

are recognized, the purple-fruited ahuasiqui negro *(P. gentryi* f. *gentryi)* and the yellow–to–scarlet–colored ahuasiqui blanco *(P. gentryi* f. *flavipulpa)* (Fig. 2) (Laferrière 1989b). The latter is considered less astringent than the former. Capulín *(Prunus serotina* var. *virens)* (Fig. 3) is also present in similar habitats, but is underutilized because of its astringent taste. Parra *(Vitis arizonica* Engelm.,

FIG. 2.—Fruiting branch of ahuasiqui blanco *(Prunus gentryi* f. *flavipulpa).*

FIG. 3.—Fruiting branches of capulín *(Prunus serotina* var. *virens).*

Vitaceae) is also present in shaded canyons, but rarely yields enough fruit to make a foraging trip worthwhile. This plant is more esteemed for the use of its leaves to treat pimples. The fruits are, however, consumed in the southwestern United States (Castetter 1935; Palmer 1878).

Berberis pimana Lafer. & Marr. (Berberidaceae), variously called palo dulce, palo aigre, or palo amarillo, is common in shaded canyons, and is eaten raw by some persons but disliked by others because of its strong acidity (Laferrière and Marroquín 1990). Norton *et al.* (1984) reported proximate composition of *Berberis nervosa* Pursh. similar to our figures for *B. pimana* except for a somewhat higher protein value (18% dry weight). They also reported values of 1.91 mg calcium, 3 mg iron, 85 mg magnesium, 5 mg zinc, and 145 mg ascorbate per 100 g. Petcu (1965, 1966, 1968) reported ascorbate contents ranging from 329 to 525 mg per 100 g fresh weight of fruits of various Romanian species of *Berberis*. Wierzchowski and Bubicz (1959) reported 92 mg β-caratene per 100 g fresh fruit pulp of *B. vulgaris* L. Thirteen species of *Berberis* from the Soviet Union ranged from 22.0-73.3 mg/100 g, vitamin C and 0.41-1.17% sugar (Kharitonova 1986). Sugars of *B. vulgaris* are predominantly galactose and arabinose but significant amounts of fucose, xylose, and rhamnose are also present (Martynov *et al.* 1984).

Berberis fruits contain compounds limiting their utilization in large quantities. Fruits of *B. siamensis* (Takeda) Lafer.[1], are eaten in Thailand and considered diuretic and a demulcent in dysentery (Ruangrungsi *et al.* 1984). Many alkaloids are known from the root bark of *Berberis* spp. (List and Horhammer 1972) and a few have been isolated from fruits (Brazdovicova *et al.* 1980).

Manzanilla (*Arctostaphylos pungens* H.B.K., Ericaceae) is very common in certain drier areas, forming open thickets with *Quercus chuhuichupensis* Muller. Its dry, amber-colored fruits are eaten raw in June and July by the Mountain Pima, Tarahumara, Zapotecs and Warihío (Pennington 1963; Gentry 1963; Uphof 1959). Fruits of various species of *Arctostaphylos* have been consumed in large quantities by the natives of California, either fresh or dried (Wickson) 1889; Balls 1962; Ebeling 1986). A cider can also be made from the fruits of several species (Ebeling 1986; Wickson 1889; Palmer 1978). The fruits, though edible, tend to be dry and mealy, and difficult to digest in large quantities (Harrington 1967; Kirk 1975). *Arctostaphylos uva-ursi* (L.) Spreng, is called "mealy-plum" is Massachusetts because of its dry, puckering contents (Sanford 1937). Our high fiber figures support these observations. Kuhnlein (1989) reported similarly high fiber figures for *A. uva-ursi*. Leung and Flores (1961), however, reported a fiber value of only 4.62% dry weight for fruits of *A. tomentosa* Pursh. Seeded, dried fruits of *A. pungens* may contain over 40% sugar and 16% citric acid (Martínez 1939).

Fruits of *A. pungens* contain arbutin, and have diuretic properties (Sociedad Farmacéutica Méxicana 1952). Dried fruits are used in Baja California to treat gall bladder and urinary tract infections (Winkelman 1986). These compounds as well as the high fiber content prevent consumption of large quantities of fruit.

Orange fruits of madroño (*Artutus xalapensis* [Fig. 4] and *A. arizonica)* mature in October. Madroño trees are fairly common in forested regions and along shaded arroyos. Fruits of both species are eaten by both the Tarahumara and Tepehuan (Pennington 1963, 1969). Other species have beon utilized in the United States (Balls 1962).

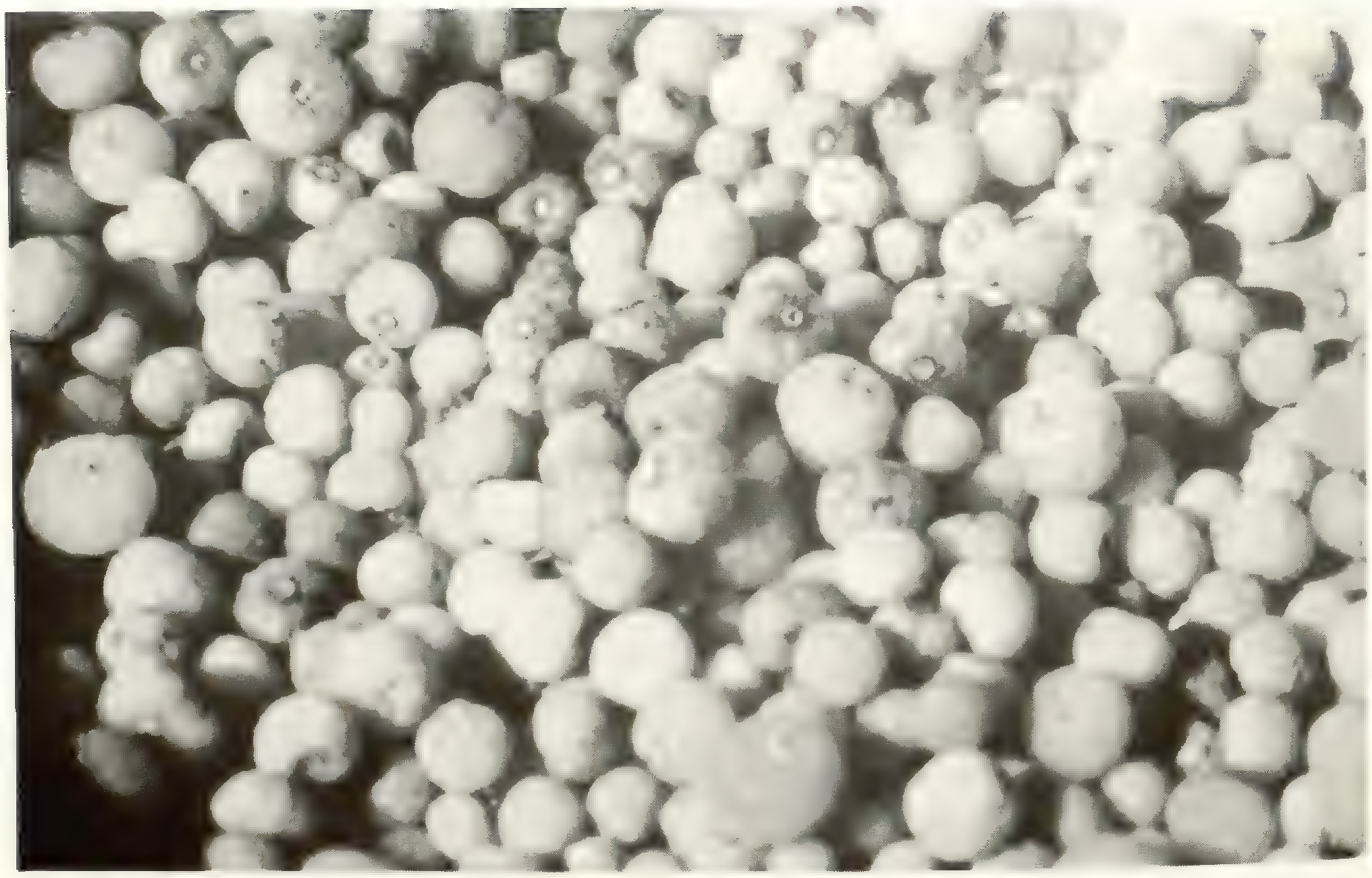

FIG. 4.—Fruits of madroño (*Arbutus xalapensis*).

Tonolochi (*Passiflora bryonioides* H.B.K. and *P. quercetorum* Killip, Passifloraceae) is occasionally found on drier canyon walls and in protected locations in manzanilla thickets. The whitish fruits are occasionally eaten by children. Fruits of several species of *Passiflora* are widely utilized as food sources in many tropical countries (Martin and Nakasone 1970), orange fruits of palo del venado (*Lonicera cerviculata* S.S. White, Caprifoliaceae) are considered edible but are not frequently eaten because of their relative rarity.

Fruits of the weedy tomatillo (*Physalis caudella* Standl., Solanaceae), common in agricultural fields, are consumed green or ripe, primarily by children. Two other related species, collectively called tomatillo chiquito (*P. minima* L. and *P. microcarpa* Urban & Ekman) are present in forested areas and beneath taller vegetation in agricultural fields, and are also eaten occasionally, but are too small and rare to be of much use. Fruits of *Physalis* spp. are widely utilized in several countries (Gibbons 1962; Harrington 1967).

Fruits of tulusin (*Jaltomata procumbens* (Cav.) J.L. Gentry, Solanaceae) are also consumed. *Jaltomata prucumbens* is a common weed in much of Mexico and Central America. It is often encouraged by farmers because of its edible berries, and some populations demonstrate some evidence of domestication (Davis and Bye 1982).

Solanum diphyllum is a red-fruited species native to the Sierra Madre and occasionally cultivated there as an ornamental. The Mountain Pima sometimes eat the fruits, but also use them to make wreaths in holiday decorations (Laferrière and Van Asdall 1991b).

The Mountain Pima recognize fruits of *Rhus trilobata* Nutt. (Anacardiaceae) as edible but do not use them extensively due to their relative scarcity. These

fruits are used in Arizona and California because of their pleasant acidic taste, due to malic acid in the hairs on the fruit (Hodgson 1982; Balls 1962). Piñones (seeds of *Pinus discolor* Bailey & Hawksworth, Pinaceae) are available at lower elevations.

Immature fruits of savaliqui (*Yucca grandiflora* Gentry, Agavaceae) and jamole (*Y. madrensis* Gentry) are also occasionally consumed (Gentry 1972; Laferrière 1990b). Fruits of several other species of *Yucca* were commonly consumed in the southwestern United States (Castetter 1935; Ebeling 1986). Green fruits of *Y. madrensis* are eaten by the Warihio as well as the Mountain Pima (Gentry 1972; Laferrière 1990b). *Yucca grandiflora* is also utilized at lower elevations in the canyons south of Yepachi (Gentry 1972). Fruits of several other species have been consumed in the southwestern United States (Yanovsky 1936). Fruits of both the Mountain Pima species are dry and inedible when mature.

Greens.—Quelites, or wild edible greens, constitute a significant portion of the diet during the early part of the summer rainy season, when the plants are young and tender. The most commonly utilized species include quelite de mayo (red-leaved individuals of *Amaranthus hybridus* L., Amaranthaceae), quelite de agua (white-leaved *A. hybridus*), chuale (*Chenopodium leptophyllum* Nutt., Chenopodiaceae), and verdolaga (*Portulaca oleracea* L., Portulacaceae).

Caña aigre (*Begonia gracilis* H.B.K. ssp. *nervipilosa* A. DC., Begoniaceae) is common in moist, shaded locations, and is occasionally consumed by children. The stalks are juicy, mucilaginous, and pleasantly acidic. Hierba aigre (*Oxalis decaphylla* H.B.K. and *O. albicans* H.B.K. ssp. *albicans*, Oxalidaceae) is treated the same way. Shoots of *Begonia* and *Oxalis* are acidic due to the high concentration of oxalic acid, which is potentially toxic in large quantities (Laferrière 1990c, 1991a). Fortunately, the children do not consume enough of these plants to cause noticeable harm. Shoots of *O. divergens* Benth. are used by the Mountain Pima as tea to relieve fatigue (Pennington 1973). Cravioto (1951) gave a figure of 3.7 mg carotene per 100 g *O. divergens*. Shoots of *B. gracilis* are used in treating toothache or gum disease (Pennington 1973).

Subterranean organs.—Roots of saraviqui (*Prionosciadium townsendii* Rose, Apiaceae [Fig. 5], listed as *P. madrense* S. Wats. by Dunnigan [1970]), are eaten in August or September after the leaves turn brown. The species grows primarily along the steep sides of shaded arroyos, and is not very common in the area. The entire plant, including both above- and below-ground portions, is pleasantly aromatic. The roots of prereproductive specimens of this semelparous species are roasted in the fire, and considered as good as potatoes. The plant was much more common in the past but has declined in abundance due to extensive grazing pressure. The smaller purple-flowered relative, *P. madrense* is considered edible by some people but bitter by others. The Tarahumara consume *P. serratum* Coult. & Rose (Pennington 1963).

The Mountain Pima have eaten boiled tubers of kachana (*Dahlia coccinea* [Fig. 6] and *D. sherffii* Sorenson), although their use is declining. Tubers of *Dahlia* spp. were widely used in pre-Spanish Mexico and are very high in inulin and fructose

FIG. 5.—Root of saraviqui *(Prionosciadium townsendii)*.

FIG. 6.—Tubers of kachana *(Dahlia coccinea)*.

(Whitley 1985). Tubers of *D. coccinea* have antibiotic and antiatherogenic properties and act as central nervous system depressants (Whitley 1985; Jiu 1966).

Tubers of grulla (*Cyperus esculentus* L., Cyperaceae) are occasionally eaten during planting season, mostly by children. This plant grows abundantly in the fields, and since the tubers are produced above the level from which the plows throw up the soil, the plants and the intact tubers are pushed upward and can be gathered very easily. The tubers are gathered and eaten raw in the field with only a minimum of cleaning. They are reported to be very sweet, but do not constitute a major source of food because ef their extremely small size, only a few millimeters in diameter. This widely distributed species is utilized in many countries. Raw tubers contain 43.9% carbohydrate, 17.2% lipid, and 4.4% protein by fresh weight (Mokady and Dolev 1970).

The name "cebollín," from the Spanish "cebolla," meaning "onion," is shared by at least two wild species of *Allium* (Liliaceae) as well as the much larger *Hymenocallis pimana*. *Allium* bulbs are often used as a flavoring ingredient in soups and fried dishes. *Hymenocallis* is very common in permanently fallow fields, forming showy displays of white flowers early in the summer rainy season (Laferrière 1990a). The large bulbs, which resemble onions but without the odor, were eaten during famines until the first part of this century (Laferrière 1989b). The bulbs were first boiled in lye to extract the bitter, toxic alkaloids (Laferrière 1989b).

Epiphytes.—Inflorescences of the epiphytic bromeliad "flor de encino" (*Tillandsia erubescens* Schlecht.) (Fig. 8) are occasionally eaten, and are reputed to be very sweet. The species flowers from March through May, and is thus one of the few

FIG. 7.—Roasted leaf bases of chugilla (*Agave shrevei* ssp. *matapensis*).

FIG. 8.—Flor de encino *(Tillandsia erubescens)*.

wild plant species available in the early spring. The smaller *T. recurvata* L. is also present in the valley, but is less common. The two are ethnotaxonomically conspecific and are utilized in the same manner. *Tillandsia* has been widely used medicinally and as a source of packing material (Robinson 1947; Bennett and Zingg 1935; Laferrière 1991b), but we have been unable to locate any references to food uses for members of this genus. French and Abbott (1948) reported 1500 mg carotene and 46 mg ascorbate per 100 g fresh weight of shoot material of *T. usneoides* L.

Condiments.—Three local plant species are used in Nabogame as condiments to flavor beans. Oregano grande *(Monarda austromontana* Epling, Lamiaceae) is very common in permanently fallow fields, while the smaller, rarer oregano chiquito *(Hedeoma patens* Jones, Lamiaceae) is found in small clumps on the walls of

shaded canyons. These, as well as *H. floribunda* Standl., are used in a similar manner by the Warihío (Gentry 1963). Pazote or epazote *(Teloxys ambrosioides* (L.) W. Weber, Chenopodiaceae; = *Chenopodium ambrosioides* L.) is used in a similar manner.

Our figures for mineral composition for the two species of wild oregano correspond closely to values given for the cultivated *Origanum vulgare* L. (Lamiaceae) (Marsh *et al.* 1977). Some of the organic constituents of both species, however, may be potentially toxic in large amounts. Foliage of *Hedeoma pulegioides* (L.) Pers. contains pulgenone, a terpene capable of causing dermatitis and, in large doses, death (Duke 1985; Sleckman *et al.* 1983). The plant has been widely used to treat headache, flatulance, colds, bowel disorders, and rheumatism (Duke 1985). *Monarda didyma* L. (Oswego tea) and *M. fistulosa* L. (wild bergamot) have been used in the eastern United States as tea and as condiments in cooking (Medsger 1939). The most common essential oil of *M. fistulosa* is thymol in the shoots, borneol in the roots (Heinrich *et al.* 1983; Pfab *et al.* 1980). Shoots of *T. ambrosioides* have been widely employed as anthelmintics but have been replaced by less toxic drugs (Claus *et al.* 1970; Osol and Rarrar 1960). The herbage contains 0.35% volatile oil, of which 45-70% is ascaridol (Ayensu 1981). The Mountain Pima use the plant in treating colic (Pennington 1973).

Wild chiltepines *(Capsicum annuum* L. var. *aviculare* (Dierb.) D'Arcy & Eshbaugh, Solanaceae) are used to make chili and salsa, and are used to flavor beans, potatoes, and other foods. These are highly prized by the Mountain Pima but are relatively rare. Some people travel as much as three days to collect the fruits.

CONCLUSIONS

A few of the noncultivated species used by the Mountain Pima probably served as important energy sources in the past, especially the subterranean organs. *Prionosciadium townsendii* is still an important starchy food, while quelites and *Opuntia* spp. are still consumed in large enough quantities to supply a significant number of calories. Foods such as *Hymenocallis pimana* and *Dahlia* spp. probably supplied large amounts of starch in the past.

Most of the species, however, were probably more important as sources of micronutrients. Studies among the Tarahumara (Cerqueira *et al.* 1979; Connor *et al.* 1978) and other peoples have emphasized the importance of quelites as sources of vitamins A and C. While these and other noncultivated foods are certainly important in vitamin nutrition during the summer months among the Mountain Pima as well, they are lacking at other seasons of the year. Some vitamin A can be stored several months in the liver (National Research Council 1980) but the water-soluble vitamin C must be consumed regularly. There are no known good sources of vitamin C in the traditional Mountain Pima winter diet other than potatoes.

Mineral contributions from noncultivated resources may be as important as vitamins. Several of the plants analyzed showed high amounts of calcium and magnesium, although oxalate concentrations interfere with calcium utilization in *Opuntia, Agave, Begonia, Oxalis, Amaranthus, Chenopodium,* and *Portulaca.* Poten-

tially toxic compounds in some species, especially *Arctostaphylos pungens* and the three condiments, prohibit their use as important sources of micronutrients.

In times past, ashes were used in place of salt, pine ashes being preferred over those of oak since the former were not as strong. These ashes when added to food undoubtedly contributed significant amounts of minerals to the diet. Iodized salt is now purchased commercially and used frequently on beans, potatoes, and eggs. This may lessen the traditional dependence on noncultivated foods for these nutrients.

NOTE

[1]***Berberis siamensis*** (Takeda) Laferrière, comb. nov.—*Mahonia siamensis* Takeda, Kew Bull 1915:422, 1915. See Moran (1982) and Laferrière and Marroquín (1990) for a discussion of the status of *Mahonia*.

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BOOK REVIEW

The Archaeology of Animals. Simon J.M. Davis. New Haven: Yale University Press, 187. Pp. 224.

As the title implies, this book has a very broad scope including most aspects of what has become known as the field of zooarchaeology or archaeozoology. It includes chapters on the methods that are employed in zooarchaeological research, the nature of the archaeological remains, analyses of the evidence of past environmental conditions and season of death of prey items, of prehistoric hunting, of the origin and development of domestic animals, and concludes with a case study of the changing uses of animals throughout the prehistory of Britain all of which is based on animal remains associated with archaeological sites. Thus, the book is organized in a chronological sequence using this framework to discuss the finds of many fascinating zooarchaeological studies. The geographic emphasis is Europe and the Near East but additional examples are drawn from around the world. The taxonomic emphasis is upon mammalian remains, but by no means, exclusively so.

Excellent examples were chosen to illustrate different topics throughout this book. These examples are both clearly described and very well illustrated with combinations of graphs and drawings of the organism or skeletal element, maps of distributions, photographs and drawings of animals and their parts. These all contribute to a most interesting book which clearly presents many of the best examples of zooarchaeological research and its full ramifications.

Any author covering such a broad field of inquiry must set some limits on the topics to be given prominence. Within the chronological framework the author has presented varied examples for as complete an understanding of the prehistoric uses of animals as possible. The one area that received less coverage is evidence of the fishing and shellfish gathering peoples and the related problem of integrating data from different animal classes.

The audience for this publication would be anyone interested in the history of the exploitation and domestication of animals. I believe it is especially designed for the student of zooarchaeology with particular interest in the prehistory of Europe and the Near East. It would also serve well as a basic text for the study of zooarchaeology with the addition of supplementary information appropriate for other regions of the world.

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USE OF POLLEN CONCENTRATION IN PALEOPHARMACOLOGY: COPROLITE EVIDENCE OF MEDICINAL PLANTS

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ABSTRACT.—Nearly 2,400 plant species have been documented ethnographically as having medicinal value among Native Americans. Therefore, it is not surprising that evidence of medicinal plants appears in some of the over 1,000 coprolites analyzed from the southwestern U.S. Three medicinal species identified in pollen analysis of coprolites are discussed. Willow *(Salix)* is the most common analgesic in the Native American pharmacopoeia. Prehistoric use of this plant is documented in coprolites from Bighorn Cave in the Black Mountains of Arizona and also in a burial from the Mimbres Valley, New Mexico. Historically, Mormon tea *(Ephedra)* served as a diuretic. Prehistoric occupants of Bighorn Cave and the Rustler Hills of far western Texas utilized this plant. Creosote *(Larrea),* with antidiarrheal properties, has been documented in the Rustler Hills as well. These remains demonstrate the antiquity of folk remedies and provide circumstantial evidence of certain disorders suffered by prehistoric peoples. Also discussed are palynological procedures that are useful in identifying dietary and medicinal pollen types.

RESUMEN.—Se documentaron casi 2400 especies de plantas con valor medicinal usadas por los Indígenas de América. Por eso no es gran sorpresa que la evidencia de las plantas medicinales se hallaron en algunos de los más que 1000 coprolitos analysados del Suroeste de los Estados Unidos. Se discuten tres especies medicinales identificadas por el análisis palinológico de los coprolitos. El sauce *(Salix)* es el análgesico lo más común en la farmacopea de los Indígenas de América. Se documentaron el usado de esta planta en los coprolitos de la Caverna Bighorn de la Sierra Negra de Arizona, y también en una tumba en el Valle Mimbres, Nuevo México. Historicamente, el té mormôn *(Ephedra)* ha servido como diurético. Los habitantes prehistóricos de la Caverna Bighorn y del Cerro Rustler del Oeste de Taxes utilisaron esta planta. Se documenta también el creosote *(Larrea),* que

tiene los efectos contra la diarrea. Estos restos muestran la antigüedad de los remedios populares y dan la evidencia circunstancial de algunas enfermadades que afligaron a la gente prehistórico. Se discuten también los métodos palinológicos que son útiles para la identicación de las especies de polen dietético y medicinal.

RESUME.—On a documenté presqu'à 2400 espèces des plantes avec de la valeur medicinale chez les Natifs de l'Amérique. Donc ce n'est pas une grande surprise que la preuve des plantes medicinales apparaît dans quelquesunes des plus que 1000 coprolites analysées de Sud-ouest de l'Etats-Unis. On discoute trois espèces medicinales identifiquées par l'analyse palynologique des coprolites. Le saule *(Salix)* est l'analgésique le plus commun dans la pharmacopée des Natifs de l'Amérique. On documente l'usage de cette plante dans les coprolites de la Caverne Bighorn des Montagne Noires de l'Arizone, et aussi dans une tombe dans la Vallé Mimbres, Nouveau Méxique. Historiquement, le té mormon *(Ephedra)* a servi comme diuretique. Les habitants préhistoriques de la Caverne Bighorn et des Coteaux Rustler de l'Ouest de Texas ont utilisé cette plante. On a documenté aussi le créosote *(Larrea),* qui a des effets contre la diarrhée. Ces restes montrent l'antiquité des remèdes populaires et donnent la preuve circonstancielle de quelques maladies qui ont affligé des gens préhistoriques. On discoute aussi des procèdes palynologiques qui sont utiles avec l'identification des espèces du pollen diétique et medicinal.

INTRODUCTION

A pharmacopoeia was integral in each ancient health care system. Medicinal compounds used were mostly derived from plants. Some have been documented in texts from the Old World (Manniche 1989; Perrot 1987), and at least one codex documents a New World pharmacopoeia (Ortiz de Montellano 1975). However, for most ancient New World cultures, no written record exists of the plants utilized for medicinal purposes. In the absence of textual documentation, ethnographic analysis of extant or historical native Americans has provided the bulk of our knowledge of New World pharmacopoeia (Etkin 1988; Moerman 1986).

Coprolite analysis provides a means to view plants or plant parts directly consumed by humans, including evidence of medicinal plants. The plant remains recovered offer a perspective on ancient plant use that can complement or enhance modern ethnographic data. To date, from the American Southwest macroscopic vegetal analyses of over 1,000 coprolites have been completed. In some cases, evidence of possible medicinal plants has been discovered, including Fry's (1977) find of hallucinogenic *Cornus* bark in a coprolite from Utah, and Reinhard and colleagues's (1985) find of possible use of *Chenopodium* spp. as an anthelmintic.

Psychotropic plants have been recovered from several sites, although not associated with coprolites. Adovasio and Fry (1976) report numerous finds of such plants in the lower Pecos region of Texas and from Coahuila, Mexico. The species found are *Sophora secundiflora* and *Ungnadia speciosa*. These date from 7,500 B.C. to A.D. 1,000.

Microscopic analysis of pollen provides another avenue of examining plant remains in coprolites (Aasen 1984; Adams 1980; Bryant 1974a, 1974b, 1986; Bryant and Williams-Dean 1975; Hevly 1964; Hevly *et al.* 1979; Hill and Hevly 1968; Martin

and Sharrock 1964). Pollen analysis of coprolites was pioneered by Hevly, Sharrock and Martin (Martin and Sharrock 1964). Pollen is introduced into the intestinal tract through the consumption of flowers, foliage and seeds of certain species (Adams 1980; Bohrer 1968). Most published pollen analyses document dietary usage of plants. Hevly (1964; Hill and Hevly 1968) was the first individual to identify medicinal plant pollen in fecal remains. In this instance, pollen of *Sphaeralcea* was recovered from an infant burial.

The purpose of this paper is to identify the extent of medicinal plant usage in the southwestern U.S.A. in both time and space. Discussed below are recent palynological examinations of coprolites that have produced possible evidence of medicinal plant consumption. Three medicinal taxa are discussed: *Ephedra* (mormon tea), *Larrea* (creosote) and *Salix* (willow). The coprolites analyzed come from three prehistoric cave sites and one open Mimbres site. Granado Cave and Caldwell Shelter 1 are located in the Rustler Hills of west Texas and contain cultural deposits that date between A.D. 200–1400. Hamilton believes the coprolites are recovered from levels that date to approximately A.D. 700. Bighorn Cave is located in the Black Mountains of western Arizona and coprolites recovered from this cave date to A.D. 600–900. In addition, a coprolite recovered from a Mimbres burial from the NAN Ranch Ruin, New Mexico was analyzed (ca. A.D. 1,000). The Mimbres coprolite represented the colon contents of the burial (Shafer *et al.* 1989). In the case of the burial, control soil samples were taken from the pelvis and knee areas and were analysed to provide a comparative base for the pollen remains from the coprolite.

MEDICINAL VALUE OF PLANT TAXA

The three taxa under study are among the most common plants in the Native American pharmacopoeia (Moerman 1986). We suspect that these plants were used to make tea, as will be discussed below. Strictly defined, 'tea' refers to an aqueous infusion of *Camellia sinensis*. For the purposes of this paper, the term tea refers to an aqueous infusion of the plants considered here.

Salix (willow) contains salicin, an analgesic. Its analgesic use has been documented ethnographically among many New World indigenous cultures (Vogel 1971; Moerman 1986). The compound is typically ingested as a tea.

Moerman (1982) discusses the uses of *Ephedra viridis*. He notes its use as a remedy for venereal disease by traditional hunter-gatherer (Paiute, Shoshone) and agricultural (Zuni, Pima, Hopi) peoples. It is unlikely that this was a cure for venereal disease, but rather used to reduce symptoms of such disease (Kieth Manchester, Mary Lucas Powell, pers. comm.). Moerman also notes that the tea was used as an antidiarrheal by Tewa, Paiute and Shoshone, and as an anti-rheumatic by the Paiute. In addition, the plant is also used as a burn dressing, a cold remedy, and a treatment for bladder and kidney disorders.

One active compound in at least Asian and Spanish *Ephedra* species is ephedrine. Ephedrine causes "the constriction of blood vessels, rise in blood pressure, dilation of pupils, and relaxation of the intestinal and bronchial muscles" (Moerman 1982:19). Contemporary uses of ephedrine include reduction of nasal congestion due to colds or allergies. Ephedrine is not present in North American

Ephedra species (Norman R. Farnsworth, College of Pharmacy, University of Illinois at Chicago, pers. comm.). Consequently, identification of biologically active compounds in North American species awaits further research.

Larrea also has medicinal value (Lewis and Elvin-Lewis 1977; Moerman 1986). As a hot tea, decoctions of *Larrea* have been used as a treatment for diarrhea. In addition, it is also a Mexican folk remedy for bladder ailments and for removing calcium deposits from kidneys (Holloway 1985).

In the Southwest, *Larrea* and *Ephedra* were used in conjunction for the treatment of disease. Train *et al.* (1982) note that Paiutes boiled the leaves of both plants together to make a tea which was taken internally for gonorrhea. A reduction of the tea, mixed with badger oil, was used as a salve for burns.

The above mentioned plants were used in the treatment of mundane ailments common to most peoples. None of these ailments, except for certain venereal infections, leave osseous traces to be found by paleopathologists. Thus, the find of these medicinal plants provides not only time depth for the study of traditional medicines, but also documentation of minor maladies experienced by prehistoric peoples.

POLLEN PROCESSING PROCEDURE

For Bighorn Cave and the Mimbres burial coprolite analyzed by Reinhard, portions of the coprolites, each weighing 1.0 gram, were rehydrated as described by Bryant (1974b) and Fry (1977) in 0.5% trisodium phosphate for 48 hours. During rehydration, a *Lycopodium* spore tablet was added to the coprolites. Each *Lycopodium* tablet contains 11,200 plus or minus 400 spores. By calculating the number of pollen grains to spores, the approximate number of pollen grains per gram of coprolite can be determined.

After rehydration, the coprolites were disaggregated with a magnetic stirrer. They were then screened through a 300 micrometer mesh screen and the microscopic material passing through the screen was collected in a beaker and concentrated by centrifugation.

After the microscopic remains were washed and again concentrated by centrifugation, they were treated with 72% hydrofluoric acid. This process dissolves fine silicates. The concentrated remains were transferred to 700 milliliter plastic beakers and about 50 milliliters of acid were added to the soil. After stirring, the samples were set aside for 24 hours to allow for completion of the reaction. After 24 hours, the remaining sediments were concentrated by centrifugation. The sediments were then washed with distilled water to remove residual hydrofluoric acid.

After the water washes, distilled water was added to the samples in 50 milliliter centrifuge tubes. The tubes were then placed in a sonicator and sonicated for 4 minutes. This treatment loosens fine organic debris and separates the microscopic particles. After sonication, the remains were transferred to 12 milliliter glass centrifuge tubes and the sediments were concentrated by centrifugation and the supernatant poured off. A zinc bromide heavy density mixture (specific gravity 2.0) was added to the tubes. The samples were then mixed into the zinc bromide and the tubes were spun in a clinical centrifuge at 1,500 rpm for 15 minutes. This

process results in the separation of light organic remains, including pollen grains, from heavier organic detritus. The light remains float to the surface of the heavy density mixture and are easily removed. The heavy detritus sinks to the bottom of the tubes. The floating material was concentrated by centrifugation in 12 ml tubes.

The samples were processed further to extract pollen by acetolysis. The samples were washed twice in glacial acetic acid. Then an acetolysis mixture (9 parts acetic anhydride to one part sulfuric acid) was added to the tubes which were then heated for 20 minutes. The acetolysis treatment dissolves several organic compounds, the most important of which are cellulose and chitin. After the acetolysis treatment, the samples were washed once with glacial acetic acid and then with distilled water until the supernatant was clear.

The microscopic remains were then treated for 30 seconds in 5% potassium hydroxide to dissolve humic compounds. After several water washes the supernatant was clear and the microscopic remains were transferred into vials with glycerol.

Microscopic examination was accomplished by placing a drop of glycerol containing the suspended pollen onto a microscopic slide. A coverslip was placed over the drop and sealed with commercial nail polish. After the polish dried, the slides were examined with a binocular compound microscope. The pollen preparations were examined at 400 power. From each slide, a minimum of 200 pollen grains were identified and tabulated. It has been determined that a minimum of 200 grains is necessary for a statistically valid count (Barkley 1934; Bryant and Holloway 1983). The counts provided the basis for percentage expressions of the taxa in the pollen spectra from the coprolites. *Lycopodium* spores were also counted and, as noted above, the ratios of spores to pollen grains were calculated which was then used to calculate the number of pollen grains per gram of coprolite. In addition, pollen aggregates were counted, if present.

The analysis of coprolites from Caldwell Shelter 1 was completed by Holloway (1985) and the analysis of Granado Cave was done by Robert E. Murry (n.d.). Their procedures are similar to those described above with the important exception that *Lycopodium* spore tablets were not added to the coprolites. Holloway examined eight of 20 coprolites and Murry examined 16 coprolites for pollen.

INTERPRETING POLLEN RESULTS

As demonstrated by several researchers (Bryant 1974a, 1974b, 1986; Bryant and Williams-Dean 1975; Hevly 1964; Hevly *et al.* 1979; Martin and Sharrock 1964), pollen analysis of coprolites and latrine sediments is a useful way of obtaining dietary data. Pollen is ingested from dietary sources and also by accidental ingestion. Accidental ingestion includes drinking water containing pollen, eating food on which ambient pollen has settled, and by processing plant materials that carry large amounts of pollen. The focus of coprolite pollen analysis is separating pollen from plants that were intentionally consumed from accidentally ingested ambient pollen.

Two pollen analysis techniques are employed in this study. The first involves calculating the percentages of pollen present in coprolites (Bryant and Holloway

1983), a technique that was first used by Hevly to identify plant pollen from a Puebloan burial (Hevly 1964; Hill and Hevly 1968). This technique is useful in isolating insect pollinated (entomophilous) taxa (Hevly 1964). The second technique is pollen concentration analysis (Kelso 1976; Aasen 1984) which allows for the calculation of the number of pollen grains per gram of coprolite. The latter technique is useful for determining whether or not wind pollinated (anemophilous) types have been intentionally consumed. Wind pollinated taxa are most often incorporated in environmental pollen rain. Of the taxa discussed here, *Ephedra* is anemophilous and *Larrea* is entomophilous. Although *Salix* pollen is derived from catkins like many wind pollinated species, it is largely pollinated by bees.

The different pollen dispersal mechanisms of entomophilous and anemophilous plants result in the differing efficiency levels for the two techniques. As summarized by Bryant and Holloway (1983), anemophilous plants produce an abundance of easily dispersed pollen grains. Anemophilous plants typically produce 10,000 to 70,000 pollen grains per anther. In contrast, entomophilous plants produce about 1,000 grains or less per anther. Entomophilous grains are typically covered with lipids that securely hold them to the anther. Consequently, entomophilous grains rarely appear in percentages greater than about 4% in the natural pollen rain. Thus, the occurrence of large percentages of entomophilous pollen in coprolites (usually 4% or more) signals the intentional consumption of dietary or medicinal plants.

Dietary origin of anemophilous pollen is more difficult to determine. As noted above, pollen of this type is produced in large quantities and is widely dispersed in environmental pollen rain. Consequently, the detection of large percentages of anemophilous pollen does not necessarily indicate the intentional plant consumption. However, accidentally ingested anemophilous pollen should include a variety of taxa. For example, in the prehistoric Southwest, grass pollen, low spine composite, and chenopod/amaranth pollen make up the bulk of the natural pollen rain, with lesser amounts of pine and juniper pollen. A pollen spectrum from a coprolite that is largely dominated by one anemophilous type suggests that this type had a dietary origin. This will be reflected by a high percentage of the total pollen spectrum being composed by a single anemophilous type.

A second means to evaluate anemophilous pollen involves the calculation of concentration, or the number of pollen grains per gram of coprolite. Assuming that environmental anemophilous pollen that is introduced by fortuitous ingestion will appear in relatively low concentrations, then anemophilous types that occur in high concentrations can be inferred as having a dietary origin. The dietary origins of pollen are the consumption of flowers, the consumption of certain seed types, the consumption of foliage which includes buds and flowers, and finally drinking teas derived from foliage or flowers.

Coprolites exhibit a large range of pollen concentration values. In the analysis of Bighorn Cave, most coprolites contained less than 100,000 grains per gram (Table 1). Four samples contained 100,000 to 1,000,000 grains per gram. Five samples exceeded 1,000,000 grains per gram. As pollen concentration increases, there is a tendency for fewer plant taxa to be recovered. For example, of coprolites with pollen concentrations less than 100,000, an average of 16 plant taxa were

TABLE 1.—*Pollen concentration values for all 21 coprolites studied from Bighorn Cave with the number of taxa found in a 200 grain count and percentages of* Salix *and* Ephedra *found in each sample.*

Concentration Value	# taxa	Laboratory #	% *Ephedra*	% *Salix*	% *Larrea*
0	0	12	0	0	0
14,300	14	1	3	4	1
16,100	12	2	2	2	0
17,100	14	17	1	10	1
20,500	18	14	2	0	4
26,000	12	6	0	2	3
26,200	19	5	2	2	1
29,300	16	9	3	15	0
29,400	23	3	0	4	2
36,300	16	10	2	1	4
53,000	19	13	1	1	5
72,300	12	4	6	2	0
114,900	7	7	0	0	0
129,000	18	18	3	2	0
150,00	11	8	0	1	0
224,000	8	11	0	86	0
1,137,000	13	16	0	61	0
2,240,00	11	20	75	1	3
2,340,00	9	21	81	0	2
4,973,000	1	15	0	100	0
5,000,000	2	19	0	0	0

recovered per coprolite. For those ranging from 100,000 to 1,000,000, an average of ten taxa were recovered per coprolite. For those coprolites exceeding 1,000,000 grains per gram, an average of seven taxa were recovered per coprolite. This suggests that as people selectively consume large amounts of polleniferous food, the diverse spectrum of environmental pollen types proportionately decreases. As a subjective criterion for distinguishing intentional consumption, I suggest that pollen concentrations in excess of 100,000 grains per gram signals intentional consumption. Pollen concentrations exceeding 1,000,000 grains per gram definitely indicate selective consumption of polleniferous foods.

Finally, it is useful to evaluate dietary consumption of windborne pollen by calculating deviation from the mean for specific taxa. In this procedure, the mean concentration of a specific taxon from a series of coprolites is calculated. In samples where that taxon significantly exceeds the mean occurrence of the taxon in all coprolites from the site, intentional ingestion is indicated. This is a third method

of identifying intentional consumption of foods containing high amounts of anemophilous pollen.

In sum, when concentration data are combined with percentage data and a statistical evaluation of deviation from the mean, one can usually make safe inferences regarding dietary utilization of even anemophilous types. For example, if pollen grains of a specific anemophilous taxon: (1) dominate the percentages, (2) occur in high concentration, and, (3) significantly deviate from the mean, then intentional ingestion is indicated.

RESULTS

All three of the taxa under study were found in coprolites from Bighorn Cave (Table 1). However, only two appear to have been intentionally consumed. *Ephedra* pollen dominates samples 20 (75%) and 21 (81.3%). Pollen concentration shows that samples 20 and 21 contained quantities in the millions of pollen grains per gram (Tables 1 and 2). The pollen from three coprolites from Bighorn Cave sug-

TABLE 2.—*Pollen percentages and concentration values for selected coprolites from Bighorn Cave.*

Taxon	Laboratory Numbers				
	11	15	16	20	21
Salix	86	100	61	1	
Ephedra			1	75	81
Larrea				3	2
Acer	1				
Artemisia			1		
Brassicaceae	8		1	3	2
Cheno Am			7	1	1
Fabaceae	1				
High Spine Asteraceae			3	1	1
Juniperus	1				
Ligulafloreae					2
Liliaceae			3		
Low Spine Asteraceae	2		14	2	6
Onagraceae			1		
Pinus	1		2	1	
Poaceae			4	9	2
Populus			1		
Quercus	2			1	1
Typha latifolia			1		
Unidentifiable			4	6	3
Yucca				1	

gests intentional consumption of *Salix* . In coprolite 11, 86% of the pollen recovered was from *Salix* and the pollen concentration value of 224,000 grains per gram was relatively high (Tables 1 and 2). Very high pollen per gram values were obtained from samples 15 and 16 (4,972,800 and 1,136,800 respectively). Both samples contained large percentages of *Salix* pollen, 61% for sample 16 and 100% for sample 15. In sample 15, the large numbers of *Salix* pollen grains exclude all other types (Tables 1 and 2). It is improbable that *Salix* would normally make up such high percentages of the normal pollen rain or that unintentional ingestion would result in such high pollen concentration values. *Larrea* pollen was present in ten coprolites from Bighorn Cave. The mean percentage occurrence of *Larrea* pollen in all 21 Bighorn Cave coprolites was 1.2. The low percentages of *Larrea* pollen in the Bighorn Cave coprolites indicate that *Larrea* pollen was accidentally ingested.

Ephedra pollen was found in three coprolites from west Texas. From Caldwell Shelter 1, one coprolite, sample 6, contained 11% *Ephedra* pollen (Table 3 and 4). No other coprolite analyzed from this cave contained *Ephedra* pollen. From

TABLE 3.—*Pollen percentages for selected coprolites from Caldwell Shelter 1 (Robert E. Murry, n.d.).*

Taxon	Laboratory Numbers			
	3	6	11	12
Salix			1	2
Ephedra		11		
Larrea	4		2	19
Alnus				1
Artemisia	7		9	3
Brassicaceae		2		1
Cactaceae	2			
Carya	1			
Cheno Am	3	2	3	2
Cornaceae			1	
Fabaceae				1
High Spine Asteraceae	2	1	5	1
Hydrophyllaceae				45
Juniperus	1	1		
Liliaceae	1		1	1
Lamiaceae				3
Low Spine Asteraceae	5	4	11	5
Pinus	3	1	2	2
Poaceae	54	79	48	11
Quercus	6		1	1
Unidentifiable	11		2	

TABLE 4.—*Pollen percentages for selected coprolites from Granado Cave.*

Taxon	Laboratory Numbers	
	1	11
Ephedra	97	87
Larrea	trace	1
Cheno Am		2
High Spine Asteraceae		1
Lamiaceae	5	
Liliaceae	trace	
Low Spine Asteraceae		1
Pinus	1	
Poaceae	1	6
Unidentifiable		3

Granado Cave, samples 1 and 11 contained 97% and 87% *Ephedra* pollen respectively. Eight other Granado Cave samples contained small amounts of *Ephedra.*

To evaluate the expected percentage of *Ephedra* in normal pollen rain, I sampled soil in *Ephedra* dominated ecosystems at Lake Corpus Christi in south Texas. Five soil samples were taken from points in which *Ephedra* dominated the community and from points where undergrowth plants dominated the community. In plant communities dominated by *Ephedra,* a wide range (8% to 45%) of the pollen rain is from *Ephedra.* The variation in count depends on whether the sample was collected in an area devoid of undergrowth plants, such as species of Apiaceae, Chenopodiaceae, Poaceae, Asteraceae, and Cactaceae, or in areas where undergrowth was thick. Lower *Ephedra* counts were derived from areas of thick undergrowth and high counts were derived from areas of sparse undergrowth.

Clearly, the percentages of *Ephedra* pollen in coprolites from the caves exceed that expected in natural pollen rain. *Ephedra* is not a dominant species in the areas around the caves. The possibility of *Ephedra* making up a large portion of the pollen rain is very remote.

Five of 24 coprolites studied from Caldwell Shelter 1 and Granado Cave contained *Larrea* pollen. From Caldwell Shelter 1, coprolite 12 contained large amounts of *Larrea* (Holloway 1985). Of the pollen recovered from this coprolite, 19% was *Larrea* pollen, a remarkably high amount for an entomophilous species. This high percentage indicates intentional consumption of *Larrea.* The other coprolites from Caldwell Shelter 1 and Granado Cave contained small amounts of *Larrea* pollen that probably have an environmental source (Table 4).

Pollen was abundant and well preserved in the coprolite from the NAN Ranch burial (Shafer *et al.* 1989). Pollen was less abundant in the control soil samples from the burial and represented a different spectrum than that of the coprolite (Table 5). The control samples taken from the midden soils show a predominance

of pollen from the Chenopodiaceae and/or the Amaranthaceae, with a strong presence of small sized pollen grains of the Poaceae (grass family). These pollen types probably reflect the natural pollen rain in the vicinity of the village. The small percentages of other pollen types such as the Asteraceae and pine are also environmental types. The next most common type of pollen in the control samples is that of maize (*Zea mays*). This pollen was undoubtedly introduced by human activity. In contrast, the burial coprolite exhibits a dominance of mustard, (Brassicaceae), willow, and maize pollen. *Salix* pollen makes up 26% of the pollen counted in the coprolite sample and the pollen concentration value from the coprolite is 456,000. Thus, the coprolite sample differs from the control sample both in the amount of pollen present and the percentages of different taxa in the pollen spectra. The high percentage and concentration of *Salix* pollen from the coprolite indicates intentional consumption of *Salix,* probably for medicinal purposes (Shafer *et al.* 1989).

The lack of macroscopic evidence of cuticle or fiber of *Larrea, Ephedra,* and *Salix* suggests that vegetative structures of the plants were not consumed. The lack of pollen aggregates is also of interest. Usually, pollen aggregates are found when floral portions of the plants were consumed. The absence of pollen aggregates indicate that flowers were not directly consumed. Yet the high pollen percentages and concentration values indicate intentional consumption of polleniferous substances.

TABLE 5.—*Pollen percentages from soil samples and coprolites recovered from the NAN Ranch burial.*

Taxon	*Coprolite*	*Control Soil Samples*		
		1	*2*	*3*
Salix	26	trace		
Apiaceae	trace	trace		
Artemisia			trace	
Brassicaceae	53			
Cactaceae		1	trace	
Cucurbita	1			
Cheno Am	8	70	56	58
Fabaceae				trace
High Spine Asteraceae			trace	
Low Spine Asteraceae	trace		trace	1
Pinus		4	trace	3
Poaceae	1	11	17	12
Typha	1			
Unidentifiable	trace	4	trace	7
Zea	10	9	21	18
Concentration value	450,000	18,600	12,600	6,700

A parsimonious explanation for the presence of large amounts of pollen with no aggregates and no macroscopic indication of foliage consumption is that the pollen was consumed in an aqueous concoction, i.e. a tea. In the process of soaking and possibly heating vegetative and floral structures in water, the light pollen grains floated into solution and were then drunk. Thus, consumption of an aqueous solution derived from foliage was the probable source of large amounts of pollen in the coprolites.

DISCUSSION

The presence of the pollen of ethnographic medicinal plants suggests their use in prehistory as medicines (Holloway 1985). However, one cannot assume that plants in prehistory were used to treat the same illness as today or that contemporary uses of medicinal plants can be projected specifically into the past. It is possible that the plant species discussed here were used primarily as food or beverage rather than as medicines. However, this certainly does not negate the medicinal value of the plants. Etkin and Robs (1982), in their study of plant utilization among the Hausa of Nigeria, found that 50% of the medicinal plant species were also classified by the Hausa as dietary plants. Spices especially tend to have medicinal value. The reader should bear in mind these points when reading the discussion below.

There is evidence that the prehistoric inhabitants of Rustler Hills, an area including the Caldwell Shelters, Books Cave, McAlpin Cave, Granado Cave and other sites, were environmentally predisposed to diarrhea. The Rustler Hills are composed of dolomite and lie in the center of the Great Gypsum Plain. The water contains very high levels of magnesium and sulphur (Holloway 1985). As pointed out by Holloway, magnesium is a component of laxatives and the high amount of magnesium in the water probably had a laxative effect on the Caldwell Shelter 1 inhabitants. Hamilton, who excavated the coprolites, is native to this area and verifies that drinking local water, including the spring closest to Caldwell Shelter 1, results in diarrhea. The most direct evidence that diarrhea was a common prehistoric malady is a high percentage of the diarrheal coprolites recovered from Caldwell Shelter 1. Hamilton notes that in the excavation of the cave, formed stools constituted a minority of the coprolites present in the cave deposits. Holloway (1985) estimates that 65% of the coprolites are diarrheal.

In light of these observations, the inhabitants of Rustler Hills may have been in need of antidiarrheal compounds such as *Larrea* and perhaps *Ephedra*. The discovery of *Larrea* pollen in high percentages in two coprolites from the area, and its dietary absence from all other coprolites studied in the Southwest outside of the Rustler Hills of the Great Gypsum Plain, suggests that at least creosote was used in the treatment of diarrhea in this area. The fact that the pollen spectrum of one of these coprolites contains 19% *Larrea* pollen is strongly indicative of intentional consumption. On the average, only 3% of the pollen from Caldwell Shelter 1 coprolites comes from *Larrea*. The fact that 11% of the pollen from Caldwell Shelter coprolite 6 consists of *Ephedra* suggests that the pollen was introduced intentionally. However, in the absence of concentration values from the coprolite, this inference cannot be verified.

The evidence of medicinal plant use at Granado Cave is equivocal. *Larrea* occurs in only two coprolites in low percentages. Therefore, it is impossible to infer intentional use of the species. However, *Ephedra* occurs in eight coprolites and two of those contain high percentages. Sample 1 and sample 11 contain 97% *Ephedra* pollen and 87% *Ephedra* pollen respectively. This is highly suggestive that *Ephedra* was intentionally used at Granado Cave.

There is no indication that the inhabitants of Bighorn Cave in the Black Mountains of Arizona were predisposed to diarrhea or other ailments by their environment; yet there is strong evidence that *Salix* and *Ephedra* were intentionally consumed. Macroscopic evidence of these plants was absent, as were pollen aggregates, which suggests that the pollen was ingested in a tea.

With regard to *Salix* at Bighorn Cave, both the pollen counts and concentration values indicate that flowers of this plant were intentionally consumed, probably in a tea derived from the foliage of the plant. The mean *Salix* pollen percentage for the 21 human coprolites studied from Bighorn Cave is 14%. From samples 11, 15 and 16 pollen percentages from *Salix* are 86%, 100% and 61% respectively. These percentage values deviate significantly from the mean occurrence of *Salix* in all coprolites from Bighorn Cave. The pollen concentration values from samples 11, 15 and 16 are 224,000, 5,000,000 and 1,000,000 grains per gram of coprolite respectively. Thus, the percentages of *Salix* pollen in these coprolites is exceptionally high and the concentration values from these coprolites are also extremely high. These data indicate that a substance, probably a tea, containing large amounts of *Salix* pollen was intentionally consumed.

A similar case can be demonstrated for *Ephedra*. The mean *Ephedra* pollen percentage for the 21 human coprolites was 9%. The *Ephedra* pollen percentages for samples 20 and 21 are 75% and 81% respectively. Both values deviate significantly from the mean. The pollen concentration values for both coprolites exceed 2,000,000 grains per gram. As in the case for *Salix*, the pollen percentages and concentrations for *Ephedra* greatly exceed what would be expected for accidental consumption. Consequently, it is highly probable that a tea derived from *Ephedra* foliage was intentionally consumed, thereby introducing large amounts of pollen into the intestinal tract.

Unfortunately, in the case of the NAN Ranch burial, there is only one coprolite to study. Fortunately, control soil samples were taken from the burial pit to provide an idea of the natural pollen rain in the area.

As noted above, the coprolite from this burial contained 26% *Salix* pollen. The high pollen concentration of 456,000 grains per gram suggests that pollen had a medicinal source when compared to the relatively low concentrations present in the soil control samples. Therefore, the moderate percentage of *Salix* pollen and the high concentration value indicate the intentional consumption of a polleniferous substance. Also, the pollen spectra from the control soils show a minimal amount of *Salix* pollen in the pollen rain at the site. In the case of the burial, it is highly likely that the pollen evidence from the coprolite connotes willow tea administered to a dying individual (Shafer *et al.* 1989).

The origin of medicinal plants has been a topic of recent interest. Moerman (1989) statistically identifies "high use" and "low use" categories for 39 plant

families. It is not surprising to find Salicaceae (willow family) classified as a high use taxon. Moerman infers mechanisms by which people originally identified high use plants as medicinal. He points out that many medicinal components are secondary compounds produced in the plants to reduce browsing. Plants signal the presence of the compound and thus experience reduced predation by browsers. The signals may be visual or olfactory. Moerman (1989) and Logan (1988) suggest that people used these signals to identify plants of potential pharmaceutical value. Therefore, the selection of medicinal plants was not random.

It is, of course, impossible to determine if these qualities in *Larrea, Ephedra* and *Salix* were recognized by prehistoric peoples as having medicinal significance. However, the plants discussed here may have attracted human attention in the manner described by Moerman. In the case of *Larrea,* olfactory signals could have stimulated human interest in the plant as a medicine. To a lesser extent this could be true of *Salix* and *Ephedra,* although these plants are not nearly as pungent as *Larrea.* The curious, leafless growth form of *Ephedra* also might have attracted the attention of prehistoric peoples, as it stands out from most other desert plants and is easily recognizable.

This argument is important with respect to the discussion of whether or not medicinal plants originated as dietary plants in prehistory. Reinhard *et al.* (1985) suggests that *Chenopodium* was used first as a dietary plant before the medicinal property of a limited number of its species was recognized. However, at least *Chenopodium graveolens,* an anthelminthic species, produces an intense odor and color change in fall. Perhaps people recognized that there were two varieties of *Chenopodium,* one including many species of dietary value and one including a few species of medicinal value. The difference between the two might have been originally defined from smell and perhaps seasonal color.

Logan (1988) adds another perspective to the origin of medicinal plants. He suggests that the introduction of agriculture resulted in land disturbance with consequent growth of pioneer species. He views agriculture as expanding the variety of plants with which humans were associated. Experimentation with some of these weedy species growing in cultivated fields led to the discovery of medicinal species.

Regardless of whether *Salix, Larrea* and *Ephedra* were first recognized as food, medicine or beverage, the coprolite evidence demonstrates that they were used in the prehistoric Southwest. It is apparent that the use of these plants began among hunter–gatherer cultures. The use of at least *Salix* continued into agricultural times.

The coprolite evidence provides important time depth for the study of the Native American pharmacopoeia. *Larrea* was used in the late Archaic of west Texas. The use of *Salix* and *Ephedra* in western Arizona began by A.D. 600. As coprolite analysis progresses, the antiquity of more medicinal plants will be documented and add an important time dimension to the study of paleopharmacology.

The paleopathological implications of the finds of these plants relate to pathology that will not be preserved in the skeletal record. Stuffy noses and colds may have been treated with *Ephedra* tea. Although the use of *Ephedra* is better

known as a treatment for venereal disease, it is unlikely that such disease was common among scattered populations of hunter–gatherers. The various pains resulting from a variety of factors, including degenerative diseases such as osteoarthritis and dental decay, were in all probability treated with *Salix* tea. Diarrhea was evidently a problem in the Rustler Hills. Direct evidence of this malady is not preserved skeletally. However, the presence of *Larrea* in coprolites, combined with modern constitutional effects observed from drinking the local water and the diarrheal form of Rustler Hills coprolites, strongly implicates loose bowels as a chronic problem for Archaic peoples who lived in the area.

The study of pollen remains from coprolites provides the potential for identifying prehistoric medicinal plants. Two aspects of pollen analysis are useful for this purpose: pollen percentages and pollen concentration. As coprolite analysis progresses, we anticipate that more information will be obtained relevant to the development of a Native American pharmacopoeia.

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BOOK REVIEW

The Sacred Mushroom Seeker: Essays for R. Gordon Wasson. Thomas J. Riedlinger, Ed. Portland, Oregon: Dioscorides Press. 1990. Hardcover, $37.95.

It is the hope of each one of us to be made immortal by our contributions to science or to history in some significant way. According to these written tributes and historical recollections, Gordon Wasson was both admired by his colleagues and noteworthy in his contributions to ethnomycology.

Each essay in this publication dwells on a different aspect of his methods of research and motivations for pursuing the objects of his interests, as recalled by his friends and colleagues. Included are some photographs which hint at the stories within the essays. There is a brief general biography and a review of his major works followed by tributes to his generous teaching habits. Bibliophile, historian, scholar and ethnobotanist are only a few of the "hats" worn by this most respected and noteworthy man. Surrounded by shadows of controversy about the subject of mushroom use and religous ceremony of the ancient and Mexican peoples, Gordon Wasson strove to document and verify the subjects of his interest. The essays contained in this volume are a fitting collection to a multifaceted man, much admired, an inspiration to many.

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BOOK REVIEW

An Amazonian Rain Forest: The Structure and Function of a Nutrient Stressed Ecosystem and the Impact of Slash-and-Burn Agriculture. C.F. Jordan [Ed.]. Parthenon Publishing Group, Park Ridge, NJ. 1989. Pp. xii + 176 plus tables, maps, photographs. $49.00. This volume represents No. 2 in a series "Man and the Biosphere."

The amount of research on which this book is based, together with the masterly use of scientifically sound literature, make this volume extremely valuable to all who have interests in our rain forests and how to save them from systematical, and unfortunately in some tropical countries, governmentally sponsored or encouraged devastation or destruction.

The primary work on which the book is in part based is the result of intensive research in San Carlos on the Rio Negro of Venezuela. This is probably one of the highest nutrient deficient areas of the northwestern Amazon due primarily to its geological composition. But this emphasis on such an area does

not detract from the wealth of information (from personal and literature sources) that applies well to many other parts of the Amazonian basin. As the author himself states, even though he understandably says that "the book does not ... attempt to present the results of the whole study [at San Carlos] ... it concentrates, instead, on a limited range of questions related to nutrient stress in tropical rain forests ..."

The other aspect of this book concerns the affects of the "slash and burn" agriculture carried on by many, if not most, native inhabitants of the Amazon. The literature is full of criticism of the slash and burn system of agriculture. As a botanical explorer who has spent 48 years in field studies in the northwest Amazon, partly at San Carlos, who has consistently defended this type of agriculture for most upland Amazonian agriculture, I am pleased to see the author did not find it wholly detrimental to agriculture and not detrimental to the ecosystem.

The volume is divided into seven sections: Introduction; The Amazon region and San Carlos site; Nutrient stress and plant/animal communities near San Carlos; Nutrient conservation mechanisms of the forest; Comparison of San Carlos forests with those of Other Tropical Regions; Slash-and-Burn Agriculture and Productivity/Nutrient Dynamics; Secondary Succession and Productivity/Nutrient Dynamics; Implications for Management. There follows four appendices: (A) Angiosperms, Mammals, Birds, Fish; (B) Small Mammals, Fish, Decomposers; (C) Soils, Forest Biomass, Forest Productivity, Post–disturbance Productivity, Nutrient Concentration in Biomass, Water Budget, Nutrient Fluxes; (D) Acknowledgements. There follows a selected bibliography of 283 references and a full index.

The Parthenon Publishing Group is to be congratulated for producing this useful and scientifically valuable book so attractively and in hard cover which will resist the constant use that the volume will certainly get.

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THE MAYA AND THE VEGETATION OF THE YUCATAN PENINSULA

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ABSTRACT.—Several hypotheses have been formulated to explain the composition and structure of the lowland tropical forest of the Yucatan Peninsula, in particular, the abundance and dominance of useful trees in mature forest communities. They commonly assume that forests in the lowland Maya area are man-made, but tend to dismiss or generalize environmental conditions in the area. Recent studies in northern Yucatan do not reflect the pattern described in the literature: abundance of useful trees in the forests. Why are useful trees, especially fruit-bearing trees, not present in all mature forest of the lowland Maya area? Our objectives are to (i) present a brief review of the literature concerning the origin of the vegetation in the Yucatan Peninsula; (ii) explain how the original vegetation structure could have changed under human influence, resulting in abundance of useful trees; and (iii) discuss the reason why useful trees are not present in all mature forest communities of the lowland Maya area, as generally assumed or suggested by many authors. The abundance of useful tree species in forests of the lowland Maya area was probably human-induced, through the years, without human assistance, they are now only present where the environmental conditions allow their survival. Even though the Maya may have played a significant role shaping the vegetation, rainfall is too variable to expect an even distribution of useful fruit-bearing trees without human assistance.

RESUMEN.—Se han formulado varias hipótesis para explicar la composición y estructura de los bosques tropicales de la Península de Yucatán, en particular, la abundancia y dominancia de especies arbóreas útiles en bosques maduros; y asumem que los bosques de las tierras bajas mayas son producto de la actividad humana, pero tienden a relegar o generalizar las condiciones medioambientales del área. Estudios recientes realizados en el norte de Yucatán no reflejan el patrón descrito en la literatura: abundancia de especies arbóreas útiles. Nuestros objetivos son: (i) presentar una breve revisión de la literatura referente al origen de la vegetación de las península; (ii) explicar como la estructura original de la vegetación pudo cambiar bajo la influencia humana y resultar en abundancia de especies arbóreas útilies; y (iii) discutir la razón por la que no están presentes estas especies en todas las comunidades boscosas de las tierras bajas mayas, tal como lo asumen o sugieren diversos autores. La abundancia de especies arbóreas útiles en los bosques de las tierras bajas mayas fue probablemente inducida por el hombre, al pasar los años, sin la asistencia humana, solo están presentes ahora donde las condiciones medioambientales se los permite. A pesar de que los mayas hayan jugado un papel significativo modificando las estructura de la vegetación, la

precipitacion es tan variable como para esperar una distribucion uniforme de especies arbóreas útiles sin asistencia humana.

RESUME.—On a formulé quelques divers hypothèses pour expliquer la composition et la structure de la forêt basse tropicalle de la Peninsule Yucatanne, particulairement l'abundance et dominance des arbres utiles dans les communautés forestales mûres. On suppose en générale que les forêts de la région basse des Maya soient de l'origine humaine, mais on congédie ou généralise les conditions environmentelles de la région. Les études recentes dans le Nord de la Yucatanne ne reflechissent pas les models décrit dans la literature: l'abundance des arbres utiles dans la forêt. Nos objectifs sont: (i) présenter un résumé bref de la literature concernante de l'origine de la végétation de la Peninsule Yucatanne; (ii) expliquer comme on pouvrait changer la structure originalle de la végétation sous l'influence humaine, avec le resultat de l'abundance des arbres utiles; et (iii) discouter pourquoi les arbres utiles ne se trouvent pas dans tous les communautes forestales mûres comme plusieurs auteurs ont supposé ou suggéré. L'abundance des espece des arbres utiles dans la forêt de la région basse du Maya est probablement de l'origine humaine. Après plusieurs années, sans l'influence humaine, les arbres se trouvent aujourd'hui seulement dans les sites où les conditions environmentelles permittent leur survivance. Bien que les Maya pouvront avoir joué un rôle important dans la formation de la végétation, la chute de pluie est trop variable pour s'attendre à une distribution unie des arbres fruitiers utiles sans l'aide humaine.

INTRODUCTION

Several hypotheses have been formulated to explain the composition and structure of the lowland tropical forests of the Yucatan Peninsula; in particular, the abundance of useful trees in mature forest communities (e.g., Barrera *et al.* 1977; Gomez-Pompa and Kaus 1987; Gomez–Pompa 1987; Gomez–Pompa *et al.* 1987; Rico–Gray *et al.* 1985, 1988b). These hypotheses assume that forests in the lowland Maya area are man–made and dominated by useful tree species, but tend to dismiss or generalize the environmental conditions in the area. Many studies on the interaction between man and vegetation were originally generated to explain the abundance of the ***ramon*** tree, *Brosimum alicastrum* Sw. (Moraceae), on or in the immediate surroundings of archaeological sites of the Maya, for example: (i) Folan *et al.* (1979) and Puleston (1972) proposed the abundance was clearly the result of human cultivation and management; (ii) Lambert and Arnason (1978, 1982) explained that archaeological sites are optimal environments for the ***ramon***; (iii) Peters (1983) suggested that the atypical autoecological characteristics (phenology, breeding systems, productivity) of some ***ramon*** tree populations (Tikal) are the product of artificial selection practiced by the Maya; and (iv) Ogata (1990) suggests the abundance of ***ramon*** in the vicinity of archaeological sites reflects the defaunation activity of Post–Classic Maya. In summary, we group the explanations for the abundance and dominance of useful tree species in the Yucatecan forests into two main hypotheses (modified from Gomez–Pompa and Kaus 1987): (1) The abundance of useful tree species is a consequence of their biological characteristics, which enables them to be very successful during the natural regeneration process of the vegetation, or in occupying man–made

ecological niches; and (2) The trees were present in the area before human occupancy but not necessarily abundant, and selection by man (protecting and cultivating) was the determinant factor to account for abundance.

Recent vegetation studies in northern Yucatan, near an archaeological site (Thien *et al.* 1982) and a Mayan village (Rico–Gray *et al.* 1988a, 1988b, and unpublished data), do not reflect the pattern described above: abundance of useful tree species. Why are useful trees, especially fruit–bearing trees, not present in all mature forests of the lowland Maya area? Our objectives are to: (i) present a brief review of the literature concerning the origin of the vegetation in the Yucatan Peninsula; (ii) explain how the original vegetation structure could have changed under human influence, resulting in the abundance of useful trees; and finally (iii) discuss the reason why useful trees are not present in all mature forest communities of the lowland Maya area, as generally assumed or suggested by many authors. The abundance of useful tree species in forests of the lowland Maya area was probably human–induced, through the years, without human assistance, they are now only present where the environmental conditions allow their survival. Even though the Maya may have played a significant role shaping the vegetation, rainfall is too variable to expect an even distribution of useful fruit-bearing trees without human assistance.

BRIEF HISTORY OF THE VEGETATION OF THE YUCATAN PENINSULA

The vegetation of southeastern Mexico has experienced a series of changes as the result of abrupt temperature and precipitation fluctuations during the Pleistocene (Toledo 1982). The study of lake sediments (pollen) in the Peten area in Guatemala (Lewin 1984; Leyden 1984) and western Honduras (Rue 1987), suggest that the mesic tropical deciduous forest dominated by *Brosimum* originated during early Holocene, approximately 10,000 to 11,000 years ago. Forests to the north, the Mexican portion of the Yucatan Peninsula, would be considerably younger and more xericphytic. The abundance of *Brosimum* pollen, compared to pollen from other tree species characterizing this vegetation, probably is due to its relative abundance. ***Ramon*** is wind–pollinated (Peters 1983) and most of the other trees in the community are insect–pollinated, thus contributing few pollen grains to sediments (Rue 1987). With the appearance of savannas and open areas ***(milpas?)***, *Brosimum* dominance probably declined, as indicated by lower levels of its pollen in sediments, and the appearance of Melastomataceae, *Byrsonima*, and the presence of Maize/*Zea* (Rue 1987). This decrease in dominance is ascribed to the initial Maya occupation of the region (3,000–1,700 B.P. for the Peten in Guatemala, Leyden 1984; 3,000 B.P. for western Honduras, Rue 1987), and continuous use until the sixteenth century. At the same time, it is interesting to note the appearance and increase of pollen depositions of *Cecropia* and *Trema* (Leyden 1984; Rue 1987), two typical tropical deciduous forest pioneer tree genera, which probably reflects major vegetation recovery processes. Rue (1987) suggests that the lack of palynological evidence for any significant late Holocene climatic change in the present or previous Central American sequences, allows the assumption that all vegetational changes are human induced. A comparison between the list

of plant genera in the palynological analyses and the one presented by Miranda (1958) in his classical vegetation survey, reveals that tree species composition of the deciduous tropical forests of the lowland Maya area must have remained very similar since Maya occupation; the only significant changes must have occurred in the structure (diversity, abundance, dominance) of the vegetation.

CHANGES IN VEGETATION STRUCTURE AND DOMINANCE OF USEFUL TREES

Vegetation structure is subject to continuous change. Whether the change is due to the effect of natural forces or human activity, three main aspects should be considered when studying the recovery process of a denudated forest patch: the length of time the area was cleared, the type of activity during this period, and the extent of the clearing. Different combinations of these factors will yield forests with very similar or very different composition and structure, relative to the original. In order to start the regeneration process one factor common to any combination of the above is the need of a source of propagules, whether the seed bank already existing in the soil, the seed rain following abandonment, or regeneration from coppice trunks. Changes in vegetation structure were no doubt directly induced by the agrosilvicultural techniques of the Maya. On the other hand, the presence, relatively close to denudated forest areas, of mature, reproductive individuals of useful tree species, had undoubtedly a significant quantitative advantage over newcomers during forest regeneration that followed the abandonment of agricultural land or urban centers. Abundant seed rains from useful tree species could originate from trees directly managed in the forest (Bartlett 1935; Denevan *et al.* 1984; Soemarwoto & Soemarwoto 1982), from those growing in homegardens or in the ***pet kot***, and from remnant forest tree individuals; seed movement from trees to open areas could have been effected by wind, bats (e.g., Peters 1983), other mammals, or birds (e.g., Scott & Martin 1984).

Present day Yucatecan Maya homegardens contain reproductive individuals of many useful tree species (Anderson 1952; Barrera 1980; Rico-Gray *et al.* 1988a, 1990; Vargas 1983). Ancient Maya followed this practice (Marcus 1982), thus the abundance of seeds from useful species is guaranteed after abandonment of a denudated forest area.

Gomez-Pompa *et al.* (1987) suggested that ancient Maya selected certain forest areas, the ***pet kot***, to plant and protect useful tree species. These stone-walled, man-made forests are recognizable today in certain areas of Yucatan, and could also be an abundant source of seeds for useful trees.

In many instances, when a forest is cleared for agricultural purposes, a number of individual trees are left untouched for later use. It has been suggested that remnant trees will become natural perching sites for both migratory and resident birds (Guevara *et al.* 1986). Frugivorous birds will drop or regurgitate seeds and fruits which fall under the canopies, contributing to an accumulation of species, which make these remnant trees regeneration nuclei.

In summary, the useful trees of the Maya were present in the area prior to their arrival, and the changes in vegetation structure that followed this event were

no doubt influenced directly or indirectly by their activities. This influence must have been particularly important in the number of seeds of useful species available for the colonization of abandoned agricultural land or urban centers.

FOREST COMPOSITION TODAY IN YUCATAN

If the presence of useful tree species was uniform in past Maya communities (Marcus 1982), as it is now (Rico–Gray *et al.* 1990), then: (1) Why are all forests in the Yucatan Peninsula not dominated by the same useful tree species (especially useful fruit–bearing trees)? (2) Why are certain Yucatecan forests, close to Maya archaeological sites or villages, not dominated by these useful trees? And (3) If a great variety of useful trees have been cultivated and protected in Maya homegardens for the past five centuries, why are they not present in forest communities today? In other words, why should widely used species as *Brosimum alicastrum* Sw. (Moraceae), *Cedrela odorata* L. (Meliaceae), *Chrysophyllum cainito* L. (Sapotaceae), *Cordia dodecandra* A.DC. (Boraginaceae), *Crescentia cujete* L. (Bignoniaceae), *Ehretia tinifolia* A.DC. (Boraginaceae), *Enterolobium cyclocarpum* (Jacq.) Griseb. (Leguminosae), *Jacaratia mexicana* A.DC. (Caricaceae), *Manilkara achras* (Miller) Fosberg (Sapotaceae), *Melicoccus bijugatus* Jacq. (Sapindaceae), *Persea americana* Miller (Lauraceae), *Pouteria mammosa* (L.) Cronquist (Sapotaceae), *Psidium guajava* L. (Myrtaceae), *Swietenia macrophylla* King (Meliaceae), be practically absent in northern Yucatean forests?

We think that the only way these questions can be answered is to consider the mosaic of ecological and environmental conditions prevalent in the peninsula; in short, the Yucatan Peninsula is not an ecological and environmental uniform unit. The answer given by locals of Tixcacaltuyub in central Yucatan, or Tixpeual in northern Yucatan, as to why these useful tree species are present in their village but not in the different–age forest communities that surround it, is that they are not there because they do not belong to that type of forest. To support this idea, we compared species composition (Sorensen Similarity Index) between the village homegardens and their surrounding forests (all shrubs and trees). The resulting similarities are, 18.2% for Tixcacaltuyub and 22.6% for Tixpeual. These low percent similarities can be explained by the presence of secondary species in the non–tended portions of the homegardens (mainly shrubs and a few non–important trees). The important homegarden trees and shrubs are only present in this environment surviving as tended species; they do not otherwise survive.

Man–induced dominance of certain useful trees in forests of the Yucatan Peninsula has been reported; in general, areas with more than 1,100 mm of total annual precipitation. Bartlett (1935) reports abundance of *Manilkara* and *Brosimum* for forests in Belize and the Peten in Guatemala; and Rico–Gray *et al.* (1985) report a forest dominated by *Manilkara, Brosimum, Bursera, Spondias,* and *Cedrela* in the Yohaltun valley in Campeche. This forest characteristic does not seem to hold for forests in the dry portions of the peninsula, even though the surveys were conducted in the vicinity of an archaeological site (Thien *et al.* 1982) and a village (Rico–Gray *et al.* 1988a, 1988b). The latter forests have some useful tree species

(Chemas and Rico–Gray 1991), like *Gymnopodium floribundum* Rolfe (Polygonaceae), but lack the useful fruit–bearing trees (e.g., *B. alicastrum, C. cainito, M. achras*), and the important timber species (e.g., *C. odorata, E. cyclocarpus, S. macrophylla*). The only areas where individuals of these tree species may be found in the north and northwest portions of the Yucatan Peninsula are: the ***cenotes***, with their special soil and humidity characteristics; the ***pet kot***, a man–made forest (Gomez–Pompa *et al.* 1987); tended in villages, whether in homegardens or dispersed throughout the village (Smith and Cameron 1977; Rico–Gray *et al.* 1990); and in the ***petenes***, a very particular coastal vegetation association (Rico–Gray 1982; Duran 1987; Rico–Gray *et al.* 1988c). Barrera (1982) argues that the presence of useful tree species *(Annona, Manilkara, Sabal, Swietenia)* in the ***petenes*** is the result of human activity.

CONCLUSION

It is clear from the analysis of the above information, that the presence today of useful tree species in mature forest communities of the Yucatan Peninsula is correlated with their ecological characteristics, whether or not they were introduced by the Maya in the past. In particular, their presence today in the drier portions of the peninsula has to be associated with present and not past human activity. Most of the useful tree species the Maya have been utilizing for at least the past six centuries are originally native to the southern, more humid, tropical forests of the peninsula (1,500 mm total annual rainfall), or were brought from similar humid forests of other areas (before and after the Spanish conquest, Marcus 1982). In the drier portions, these species cannot survive when an area is abandoned and are left to compete with native species in the recovery process of the vegetation. In short, even though useful species (especially fruit–bearing trees) must have been present in the whole peninsula associated with Mayan activity, the reason why they are not abundant, are not dominant, and , more dramatically, are not present in many Yucatecan forests (particularly those in northern Yucatan), is because they are not native to the flora and, consequently, cannot survive under the environmental conditions prevalent in the central to northwest portions of the Yucatan Peninsula. Tended species were brought from more humid areas of the peninsula, from other areas of Mexico, or from other countries; both before and after the Spanish conquest. The only places where we find combinations of these species in northern Yucatan Peninsula are the ***pet kot***, the ***cenotes***, the ***petenes***, and tended in villages; it has been suggested that propagules of these species were brought by man to these areas.

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BOOK REVIEW

Butchering and Curing Meats in China. Carl O. Levine. Canton Christian College Bulletin, No. 27. Canton, China. Canton Christian College Press. 1921. Pp. i, 41; 9 figs. Available from the Asian Comparative Collection, University of Idaho, Moscow, Idaho.

"Butchering and Curing Meats in China" by Carl O. Levine is an obscure monograph recently located by Julia Longnecker (University of Idaho), and currently being appraised as a source of information for Overseas Chinese zooarchaeological research. Zooarchaeologists studying faunas from historic sites ordinarily use ethnographic or historical sources to identify food preparation techniques and the animals used. However, such references to Overseas Chinese in America during the 19th and early 20th centuries are uncommon and usually lack detailed information on subjects of interest to faunal analysts. In contrast, Levine's monograph is systematic and detailed, describing meat processing and food species selection. The shortcomings of this monograph for zooarchaeological research are discussed below.

Levine's monograph is an early publication of Ling-non University (originally Canton Christian College), Canton, China. The title is deceiving since the principal subject of the monograph is not a desription of Chinese butchering practices. The author's preface more accurately describes the monograph as a discussion of different methods, Chinese and non-Chinese, of butchering and curing meats. The monograph was written for use by the public and students in the "Meats" courses offered at the college. Its content and organization are primarily that of a manual to be used as a training guide for students.

The principal domestic Chinese food animals are the subject of the first section. The Chinese lard and bacon type hogs, their feeding, desirability, and past use in improving European breeds, are described in detail. Less attention is given to cattle, water buffalo, sheep, goats, chickens, and geese. Most breeds and varieties of these animals are ignored or glossed over.

A middle section discusses the selection of animals for slaughter, slaughtering, and meat cutting. The criteria described for selection are health, general condition, breeding attributes, and feeding. The desirable age and size of animals for slaughter is discussed for hogs and poultry. The discussion of slaughtering and butchering procedures is geared toward small-scale operations. Most of this section addresses hog butchering, including killing, cleaning, skinning, and segmentation of the carcass. Table cuts, which are important in archaeological research on households and other points of consumption, receive only cursory attention. Some of the descriptions of specific techniques describe Chinese tools and methods. The description of scalding equipment for hog butchering is the most complete example given.

The meat curing section of the monograph primarily describes "American" methods of curing meat, including descriptions of materials, smokehouse construction, and recipes for common types of cured meats. Most of the methods described are given with Chinese climate and building materials in mind. The

remaining part of this section describes sausage-making and other meat curing activities using Chinese recipes. The seventeen recipes given include pig's feet, dried duck, puffed pig skin, meat roasting, sausage, and others. Some of these recipes are slightly westernized, including weights which have been rounded off to the nearest English unit.

This monograph provides general information on Chinese food practices which presumably resulted in the bony wastes found in archaeological sites. The Chinese methods of sticking, scalding, and rib cage cutting are described. The recipes for dried duck, in which the bird is dressed with no bone removal, and pickled pig's feet, in which "the bone is removed from the leg, leaving only the meat, skin and toes" are examples of useful information for faunal analysts. The few references to Chinese tools and methods are valuable, also. Figure 5 illustrates Chinese butchering tools. Among the tools illustrated with explanatory captions are an oriental style cleaver, knives (sticking, cutting, scraping, bone cutting), sausage funnel, hooks, and miscellaneous small tools. Albeit brief, this is one of the few descriptions and illustrations of a Chinese butcher's tool kit in print.

Although the monograph provides information on pertinent subjects, it solves few problems for zooarchaeologists attempting to build emic models to interpret faunal data from Overseas Chinese assemblages. The text describes some Chinese butchering practices, but is primarily devoted to Euro-American tradition meat cutting with adaptations to conditions in China. Levine described the integration of Chinese and Euro-American meat processing technology, as he taught it, in an attempt to improve the meat processing technology in southern China during the early part of this century. Most of his descriptions of meat cutting do not delineate how Chinese and Euro-American procedures parallel or overlap. This precludes using the monograph as a source of information about Chinese butchering techniques for comparison or model building.

Levine's monograph is a useful tool for researchers interested in Chinese food processing in China. Those reseachers interested in traditional Chinese methods of meat processing will find the description of hog processing, and the butcher's tool kits particularly useful. The major shortcoming of the reference is that Chinese and non-Chinese procedures are rarely discussed with reference to their cultural origins. Perhaps the greatest value of Levine's monograph is as an example of modernization, of interest to researchers studying intercultural contact, acculturation, and assimilation. The text provides information which would be useful to topical research on meat processing and acculturation, but is too detailed for most broad-based studies.

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CALIFORNIA INDIAN HORTICULTURE: MANAGEMEMT AND USE OF REDBUD BY THE SOUTHERN SIERRA MIWOK

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ABSTRACT.—A survey of California ethnohistoric literature reveals that the native shrub, western redbud, *Cercis occidentalis* Torr. ex Gray., was highly valued by many California Indian tribes as a source of material for basketry. Observations of redbud regeneration after lightning fires and a study in Sierra National Forest of redbud sprouting after coppicing offer evidence that redbud is adapted to periodic fires in the riparian and foothill woodland plant communities. The generous presence of redbuds in proximity to major Southern Sierra Miwok archaeological sites suggests that some element of human activity was responsible for its successful regeneration at these sites. It is proposed that the introduction of anthropogenic fire, pruning, and weeding historically maintained and enhanced populations of redbud, extending its range and distribution. Some California Indian basketmakers remember how their elders managed redbud populations with burning, and today they manipulate redbud with pruning or coppicing to encourage specific morphological and physiological properties (e.g., elongation of branches suitable for basketry; wine-red branch color for basketry designs). Drastic curtailment of burning by law has greatly reduced the extent to which this human/plant symbiosis can occur. Public land agencies are alerted to the importance of this plant in maintaining tribal ethnicity and to the need for active management of the species to meet contemporary Indians' cultural needs.

RESUMEN.—Una revisión de la literatura etnohistórica de California revela el valor que tenea el arbusto native *Cercis occidentalis* para muchas tribus indias de California, como fuente de material para la cestería. Hay evidencia que siñala que *Cercis occidentalis* es una especie adaptada a fuegos periodicos en comunidades de vegetación riparia y bosques de pie die montaña; esta evidencia se basa en observaciones sobre la regeneración de *C. occidentalis* despúes de fuegos causados por relámpagos y en un estudio que se llevó acabo en el Bosque Nacional Sierra, sobre rebrotamiento despues de podar. La presencia abundante de *C. occidentalis* cerca de las zonas arqueológicas principales de los Mowok de la Sierra Sur, sugiere que algun elemento de actividad humana fué responsable por la regeneración exitosa de la planta en estas localidades. Se propone que la introducción de prácticas tales coma el fuego de origen antropogénico, las podas y el deshierbe, mantuvieron y fomentaron las poblaciones de *C. occidentalis* a través de la historia, asi mismo extendiendo su rango y distribución. Algunos Indios de California que producen cestería, recuerdan como sus antepasados manejaban poblaciones de *C. occidentalis* a través de prácticas de fuego y actualmente las manipulan a traves de prácticas de poda y roza para fomentar ciertas propiedades morfologicas y fisiológicas (por ejemplo: elongación de ramas para canastas y color rojo oscuro para sus diseños). La actual prohibición del uso de fuego en parques

ha reducido en gran medida esta simbiosis entre humanos y plantas. Se debe alertar a las agencias públicas a cargo del manejo de recursos, sobre el papel importante que juega esta especie en la etnicidad de las tribus y de la importancia de realizar un manejo activo de la especie que satisfaga las necesidades culturales de los pueblos indios contemporáneos.

RESUME.—Une évaluation ed la literature ethnohistorique de Californie montre que l'arbuste natif l'arbre de Judée *(Cercis occidentalis* Torr. ex A. Gray) était de grand valeur chez plusieurs tribus indigènes de Californie comme une source de materiel pour les paniers. Les observations de la régénération de l'arbre de Judée après les incendies causées par les foudres et une étudie de bourgeonnement après le talis dans la Forêt National Sierra donne de l'évidence que l'arbre de Judée se soit adaptée aux incendies périodiques dans les communautés végétales fluviales et dans les forêts des contreforts. La présence copieuse de l'arbre de Judée presqu'aux lieux archéologiques importantes des Miwok de la Sierra du Sur ṣuggère qu'une partie de l'activité humaine soit responsable pour sa régénération réussi dans ces lieux. On propose que l'introduction des incendies anthropogeniques, l'élagage, et le sarclage aient maintenu et rehaussé les populations de l'arbre de Judée, et aient étendu sa distribution géographique. Quelques indigénes de Californie qui font des paniers se souviennent la méthode comme ses aînés ont empoyé les incendies pour diriger les populations de l'arbre de Judée. Aujourd'hui ils manipulent l'arbre de Judée avec le talis et l'élagage pour encourager des caractères spécifiques morphologiques et physiologiques (par example, l'élongation des rameaux pour des paniers; le couleur du vin rouge pour les dessins artistiques des paniers). La prohibition legale des incendies a réduit dans une grande mesure cette symbiose entre les plantes et les gens. On alerte les agences publiques de l'importance de cette plante dans l'entretien de l'ethnicité des tribus et du besoin du maniement actif de cet espèce pour satisfier les besoins culturels des indigènes contemporaines.

INTRODUCTION

Found in five plant communities, redbud is a widely distributed native shrub in California. Before Anglo contact, Native American weavers used redbud branches and ground stems in the construction and decoration of baskets (Merrill 1923). At least 20 different tribes utilized the branches and ground stems of redbud, spanning 22 California counties. The horticultural techniques used historically by Indians to manage redbud were burning, pruning and coppicing (Anderson 1988–1989). Coppicing is severe pruning of plants just above ground level. Knowledge of the uses and management of redbud persist in some parts of California today, having been passed down from earlier basketmakers. Southern Sierra Miwok perceived effects of coppicing on redbud are that it "strengthens the shrub."

This paper reports results from a study conducted in Sierra National Forest which quantifies the regeneration of redbud in response to simulated management practices of the Southern Sierra Miwok. A goal of the study was to test to what extent the Indians' cultural knowledge of redbud can assist scientists in their understanding of ecological systems, and also increase their appreciation of native cultures and horticultural practices. Indian horticultural practices may

prove to be a valuable source of knowledge for managing noncommercial native plant species on public lands; yet the effects of many of these cultural techniques (i.e., burning, pruning, or digging) on the vegetation have never been accurately measured by plant ecologists or resource managers.

METHODS

A series of ethnographic interviews were conducted with selected families in the Sierra Nevada at their homes and in the field during the period 1986–89. These informants totaled 32 persons and are of Southern Sierra Miwok, Central Sierra Miwok, North Fork Mono, Chukchansi Yokuts, Mono Lake Paiute, and Western Mono ethnic backgrounds. Questions were asked regarding memory and current use of specific horticultural techniques (burning, pruning, coppicing, tillage, etc.) employed to manipulate shrub species and the frequency, time of year, and intensity of these practices. The cultural purposes (i.e., straighter branches, bark color, branch length, branch diameter) for using these techniques were recorded as well as any information regarding the former abundance and distribution of native plant species. Ethnographers have published detailed accounts of California Indian plant material culture. From 1986–89 I've attempted to locate and document vegetation management information through extensive ethnohistoric research in various government, university, and private libraries.

MORPHOLOGICAL CHARACTERISTICS OF REDBUD

There are in all seven species of redbud native to North America, southern Europe and Asia, but only one, *Cercis occidentalis* is native to California (Synge 1956). The Southern Sierra Miwok Indians called the California species, Tap–pah–tap–pah (Merriam 1902).

Western redbud is a leguminous shrub that grows from 2 to 5 m tall with a dense rounded crown that almost reaches the ground. The leaves are simple, thick, round or reniform, and cordate at the base, and have from seven to nine prominent veins. They are deciduous (Sudworth 1967); their autumn display of yellow turning to red and brown rivaling that of some eastern hardwoods. Similar to riparian trees, this species loses its leaves and bears the strain of complete spring refoliation, if the substrate retains some moisture throughout the warm season (Bakker 1971).

The striking pea-shaped flowers appear before the leaves, in small fascicles along the branches (Peterson 1966). Each flower has five petals that range in color from magenta pink to reddish purple (Weeden 1981). Pollination is by bees (Dr. Herbert Baker, pers. comm. 1988).[1] Although the pink sprays can be seen from February through April, any one shrub will remain in flower only about two weeks (Munz and Keck 1973).

In autumn the branches often bear many clusters of pointed, flat, very thin pods, the upper suture with a conspicuous winged margin (Hopkins 1942). In ripening, the pods are first purple and then russet-brown, each containing an average of seven hard, bean–like seeds (Sudworth 1967). The mature pods persist into the next winter (Storer and Usinger 1963).

RANGE AND DISTRIBUTION OF REDBUD

Redbud grows in 22 counties of California and is a component of five plant communities in the state: the oak woodland, the chaparral, the yellow pine forest, the riparian woodland and the closed cone forest (Barbour *et al.* 1980; Munz 1974). It grows at elevations of 4,000 feet or less, in canyons and on rather steep slopes, in gravelly, and rocky soils along streams, where it is never flooded (Sudworth 1967). It also grows in the bottom of ephemeral streambeds in little pockets, benches or crannies of boulder outcroppings. The plant is drought tolerant and grows in a wide variety of soils, but it is usually found in rather harsh environments with depauperate, nutrient-poor soils (Stewart Winchester pers. comm. 1988).[2] It grows mostly singly, but sometimes, in sheltered situations, in shrubby clumps (Sudworth 1967).

THE VALUE AND USES OF REDBUD TO CALIFORNIA INDIANS

Redbud is of little economic importance to foresters and range managers, for it has no value as timber and receives a poor rating as browse for livestock (Sampson and Jespersen n.d.). However, horticulturalists have planted it in informal and formal gardens and landscapes since 1886 and it has been called one of California's most attractive flowering shrubs in gardeners' manuals and horticultural guides (Peterson 1966).

Although some Indian groups used other plant species (e.g., chain fern *Woodwardia fimbriata;* greenbriar *Smilax californica;* Joshua tree *Yucca brevifolia;* and rush *Juncus textilis*) to create red patterns in baskets, redbud bark was the most widely used fiber for red designs in California. In the past, at least twenty California Indian tribes utilized redbud as basketry material (Barrett and Gifford 1933; Kroeber 1976; Merrill 1923; Margaret Mathewson pers. comm. 1988).[3] Today, Indian people (i.e., Southern Sierra Miwok, Maidu, Pomo, Washo, Western Mono, Chukchansi Yokuts) still harvest these plants and use their rich red color in special patterns in their baskets (Anderson 1988-1989). The Miwok like other California Indian peoples valued redbud particularly for its branches and ground stems, which they used for structural as well as design purposes in making baskets. The plant is used in both the warp (the rods or foundation) and the weft which are structural elements of coiled and twined baskets (Fig. 1).

If used for the weft, redbud branches are split immediately after collecting or up to one month after harvesting. Branches are split in half from the thick to the thin end (Bev Ortiz pers. comm. 1987)[4] through the buds. The halves are then split again more finely to remove the pith. The material is coiled and stored for at least one year in a dry place. Later, it is soaked in water for several hours, and reshaped and cleaned before use.

Redbud is still gathered at least twice a year for different purposes. In the fall or winter, after its leaves have fallen, it is harvested for the red bark, the split fibers of which are to be used as wine-red sewing strands in decorative designs or the whole branches are used as the foundations of twined baskets. In the spring or summer redbud is harvested and the bark removed and the branch split, to be used as a white sewing strand (Anderson 1988).

THE HORTICULTURAL MANAGEMENT OF REDBUD BY THE SOUTHERN SIERRA MIWOK

Many material culture items manufactured by California Indian tribes for domestic use (e.g., looped stirring sticks, arrows, baskets) required special types of branches and ground stems. Because such branches and stems seldom occurred naturally on mature "wild" shrubs, manipulation of the plants by burning or pruning was necessary to obtain shoots of the desired characteristics in sufficient quantity.

Burning as a Management Tool.—Redbud has morphological and physiological characteristics that allow it to survive disturbances and, in the case of fire, even thrive in the reduced competition of its new habitat. Experimentation in botanical gardens has shown that redbud seeds are adapted for prolonged periods of dryness and cold and that they require special treatment to germinate, owing to an impervious seed coat plus a dormant embryo (Everett 1957). These characteristics suggest that germination of redbud seed is favored by fire, which cracks the seed coat and generates the heat needed to stimulate germination (Spurr and Barnes 1980).

Purposeful burning by Native Americans of chapparral and foothill woodland plant communities, where redbud commonly occurs, has often been reported in the ethnohistoric literature (Aginsky 1943; Driver 1937). This practice may have stimulated the germination of redbud and other species, increasing resources for basketry and other purposes.

There has been no scientific documentation of redbud's ability to sprout after fire. Yet in the Inner Coast Range, I have observed suckers from damaged boles vigorously resprouting after lightning fires. Indian informants affirm that this is indeed the case. In fact, burning was a traditional management practice of various tribes before the advent of modern pruning tools (Anderson 1989; Potts 1977; and Craig Bates, pers. comm. 1988).[5]

Prior to Anglo settlement, the initial management of large redbud shrubs required the use of fire. A sharp piece of chert or basalt was used for harvesting redbud ground stems and branches up to one centimeter diameter with ease, and up to two and one-half centimeters with more effort and time (Margaret Mathewson, pers. comm. 1989).[2] But the boles of large redbud shrubs often reach 10 or 12 cm. in diameter, and in such cases fire was used to reduce the shrub to a manageable stature. Thereafter, the resprouting stems could be kept small and straight with yearly harvesting with a basalt or chert tool or by tearing the branches from the boles (Anderson 1989).

Redbud occurs in large numbers around archaeological sites in the Sierra foothills. The shrubs decrease outward from the center of some of these archaeological sites, suggesting that the Southern Sierra Miwok utilized and maintained semi-wild redbud populations adjacent to villages. Studies are needed to interpret archaeological, ecological and historical data to determine if there is a correlation between redbud distribution and the occurrence of Indian village sites.

In the Sierra foothills, I have observed a lack of redbud regeneration, reflected in the absence of smaller size classes. Seedlings and saplings are scanty whereas

FIG. 1.—A Miwok coiled basket. The dark designs are made with split redbud bark.

most of the redbuds are mature and of tree size. The greatest number of immature redbuds are found along roadcuts. Furthermore, there are dying redbud shrubs under oak canopies. The shrub is not very shade tolerant and is outcompeted in such situations, by other species (Stewart Winchester, pers. comm. 1988).[5] Perhaps the current status of redbud reflects the absence of intense fires due to fire exclusion practices by public lands agencies, and the lack of Indian management of redbud at these sites.

Pruning and Coppicing as Management Tools.—At least two types of pruning of redbud were practiced by different tribes after Anglo contact. One technique was coppicing where the whole plant was cut within several inches of the ground (Fig. 2). The other was selective pruning within the canopy to direct the growth of the plant (Chestnut 1974; Anderson 1988). Today the Southern Miwok use both techniques to manage redbud. The shrubs are coppiced or selectively pruned one full growing season before harvest using tools such as hand saws or pruning shears (Fig. 4).

Redbud responds to pruning as it does to fire, by vigorously sprouting new shoots. The result is increased numbers of long, straight, slender switches with inconspicuous leaf scars, wine-red bark and no lateral branching. These are the

FIG. 2.—Coppicing redbud to induce rapid elongation of sprouts the following year.

characteristics most valued by the Southern Sierra Miwok and other California Indian peoples for basketry material (Fig. 3). Consistent, frequent pruning also keeps redbud shrubs of a smaller stature, with many slender boles that are easy to reach and cut, saving the basketweaver harvesting effort and time. In contrast, wild redbud has grey bark and twisted branches that are forked and often brittle; where the branches fork there is a notably more fragile area, making this section unsuitable for basketry.

Anthropologists and travelers, having spent little time in redbud habitat with California basketmakers, did not discern the difference between a "wild" plant and a "coppiced" plant, even though the shrubs display different architectures and vary in colors of bark. These observers probably did not perceive the breaking or cutting of plant parts as "management" *per se,* but rather as a destructive practice. Consequently, seldom in the ethnohistoric literature is there mention of pruning or coppicing of redbud by California Indians to meet cultural needs.

The type of sprouting that occurs on redbud after severe pruning is probably epicormic branching, which is defined as the release of suppressed buds along the bole. These suppressed buds are normal branches but submerged (Zimmermann and Brown 1980). Sprouting from the roots apparently does not occur. However, further studies are needed to understand the sprouting process fully.

The wine-red color of the redbud bark, so valuable in Indian basketry designs, appears only in juvenile wood tissue, and is the result of anthocyanin pigments.

FIG. 3.—Long, straight, slender switches of redbud with no lateral branches. These are the characteristics most valued by California basketweavers. (Switches harvested one year after initial pruning.)

These chemical substances are stored in the plastids in the cells of the cortical tissue just below the epidermis. As the branch ages it loses the color in either of two ways: (l) as the shoot expands it sheds the red bark and the cells in the mature tissue lose their ability to store or produce anthocynanins, or (2) the anthocyanins in the cortex cells are hidden by the production of bark (Richard Dodd, pers. comm. 1988).[6]

THE RESPONSE OF REDBUD TO COPPICING AND PRUNING

Most native shrubs and trees are not harmed by pruning (Schmidt 1980). In fact, many trees and shrubs, as they approach maturity, accumulate dead twigs and branches, which if not removed, may harbor pests and diseases (Brown 1972).

Harvesting and horticultural methods used by the Southern Sierra Miwok are closely related to the annual growth cycle of redbud. The Indians are keenly aware of the dormancy period of redbud, referring to this period as the time ''when the sap's down,'' and this is the preferred time for pruning. Harvesting redbud during this resting period usually is the least detrimental to its vital processes.

MIMICKING INDIAN HORTICULTURAL PRACTICES

To better understand the methods for collection and management of redbud by the Southern Sierra Miwok and to determine the shrub's response to coppic-

ing practices, I conducted an ecological field experiment which simulated one of their horticultural techniques.

The objective of the experiment was to evaluate the effects of fall coppicing on the regeneration of redbud. Regeneration was estimated by determining the numbers of shoots, both ground stems and branches, produced after coppicing.

Two sites in the El Portal area at an elevation of approximately 640 m. were selected for the experiment: (1) Dry Gulch Creek in Sierra National Forest and (2) Merced River 19 kilometers west of El Portal in Sierra National Forest and on private property. I selected healthy, mature redbud plants for the experiment. Those with large amounts of dead material, symptoms of disease, or with flood damage were rejected. I chose plants in areas where the trees had never been pruned or coppiced, inspecting for evidence of previous cutting by thoroughly checking all basal stems. The sample size for the experiment was 15 coppiced and 15 non-coppiced redbud per site. These 30 plants per site were randomly allocated a coppice or non-coppice treatment.

Before plants were cut, two measurements were taken: (1) number of ground stems; (2) number of "usable" branches. "Usable shoots" were defined as shoots with no lateral branching and a minimum length of twelve inches. These same variables were measured again after one growing season in October 1987.

Coppicing consisted of cutting the plants off at the ground level or immediately above the root crown with pruning shears or a small power saw. All shoots were removed to within a stub length of five inches.

Observations on post-coppicing growth were recorded in October 1987. The same measurements were taken (number of stems and the number of usable shoots) and any mortality noted. The differences between cut and uncut plants were assessed using a student's t-test for unpaired replicates (n = 30 each per site). An analysis of variance was performed with the data from both sites to determine the significance of differences in shoot production and ground stem production between coppiced and uncoppiced shrubs.

Numbers of usable shoots increased significantly with coppicing (Table 1) on the Merced River/private property site. Numbers of usable shoots increased tenfold with coppicing on the Dry Gulch site (Table 2), but the increase was not statistically significant. Numbers of ground stems increased with coppicing, but the difference was not significant on either site (Tables 1 and 2).

An important outcome of this experiment was that none of the redbud shrubs that had been coppiced in 1986 died. Instead, coppicing was followed by vigorous resprouting on all 30 shrubs (15 per site). Rates of growth after coppicing were fairly uniform. In October 1987, eleven months after the cutting treatment, the general appearance of the coppiced plants was distinctly different from that of the uncoppiced ones: bark color had changed from grey to wine red, branches were much straighter, lateral branches were absent or in negligible quantity, and overall height of the shrubs was less (Fig. 4).

The results from the experiment suggest that the effects of one year of coppicing were not detrimental to the target plant species and were possibly beneficial. Furthermore, the coppicing treatment at the Merced River/private property site

TABLE. 1.—Effects of coppicing on plant variables of redbud *(Cercis occidentalis)* along the Merced River, Sierra National Forest and El Portal private property.

	No Treatment		Coppiced	
	Mean ± S.E.			
Variable	1986	1987	1986	1987
Average no. of usable shoots per plant	9 ± 2*a	4 ± 1 a	21 ± 6 a	107 ± 15 b
Average no. of ground stems per plant	29 ± 5 a	26 ± 4 a	28 ± 4 a	32 ± 3 a

*Numbers for the same treatment in 1986 and 1987 followed by the same letter are not significantly different according to the student t-test (P<.05).

TABLE 2.—Effects of coppicing on plant variables of redbud *(Cercis occidentalis)* at Dry Gulch Creek, Sierra National Forest.

	No Treatment		Coppiced	
	Mean ± S.E.			
Variable	1986	1987	1986	1987
Average no of. usable shoots per plant	4 ± 1*a	2 ± 1 a	5 ± 2 a	49 ± 13 a
Average no. of ground stems per plant	8 ± 2 a	9 ± 2 a	18 ± 5 a	22 ± 4 a

*Numbers for the same treatment in 1986 and 1987 followed by the same letter are not significantly different according to the student t-test (P<.05).

showed that significantly higher numbers of usable shoots could be produced by this practice.

Recommendations which incorporate Indian management practices cannot as yet be made based on these data. In order to maintain and manage redbud, the manager must know how the plant responds to repeated coppicing through several years. Frequency of manipulation could be an important factor influencing plant vigor and productivity, requiring a multi-year study. Questions which require further research include: (1) How does coppicing in several consecutive

FIG. 4.—Vigorous sprouting of redbud on Sierra National Forest one year after experimental coppicing.

years affect the growth of a redbud shrub? and (2) What frequency of coppicing will result in maximal production of shoots of optimal quality over the normal lifespan of the plant?

CONCLUSIONS

The Southern Sierra Miwok and other California native peoples had an active role in manipulating the plant architecture of redbud with pruning, coppicing, and fire management. This offers further evidence that hunter-gatherers had the capabilities for effecting environmental changes in California plant communities. The extent to which aboriginal burning and pruning effected redbud distribution and abundance needs to be further investigated. The management of redbud for the production of branches and ground stems suitable for basketry is still practiced by members of the Southern Sierra Miwok and other California Indian tribes. The shrub remains integral to many modern tribal cultures. By repeated pruning or coppicing of redbud, Indians ensure a sustained yield of high quality shoots for basketry and simultaneously maintain he health of the plant. Public land managers, in managing redbud, should take into account this knowledge possessed by Indians.

Indian horticultural practices and resulting impacts on vegetation cannot be reliably assessed solely through the interpretation of ethnohistoric literature and ethnographic research. Vegetation productivity resulting from or related to

Indian cultural practices must be measured by experiments using methods similar to those of specific Indian groups if the cultural needs of the Indian community are to be taken seriously by public lands agencies. Ecological field experiments, therefore, can provide new data to test hypotheses regarding the possible effects on plant communities of past and present California Indian vegetation management. Specifically designed experiments also could substantiate historical and ethnographic reports regarding certain Indian plant management techniques.

Land managers have to be better informed by becoming acquainted with Indians and understanding their current cultural needs, and by conducting studies to learn about Indian harvesting and management practices and their appropriateness for public lands. During this process, resource managers will have to weigh carefully conflicts with other values and redefine cultural preservation to include the concerns of living Indians.

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I am deeply indebted to the Indian families in the Sierra Nevada for sharing their memories, crafts, and horticultural knowledge. I wish to thank Scott Carpenter and Dr. Jan van Wagtendonk, Co-Directors of the Yosemite Research Center, for their moral and logistic support. Pat Schaefer, Bill Lester, and Pete McGee gave me permission to cut redbud plants on their property and helped me with the coppicing. I am grateful to Gregory Whipple, Dr. Miguel Altieri, and Dr. Steve Edwards for reviewing the draft manuscript. Drs. Bill Waters, Arnold Schultz, Bob Martin and Jim Anderson gave valuable advice during the project. The Yosemite Association, Yosemite National Park, and the California Native Plant Society provided financial support for this study.

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SHORT COMMUNICATION

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Many fleshy fungi are consumed by the native peoples of Mexico (Gastón Guzmán, 1978, *Hongos,* Editorial Limusa, Mexico D.F.; Jose Juan Tablanda, 1983, *Hongos mexicanos comestibles: micología económica,* Fondo de Cultura Economica, Mexico D.F.), but the Mountain Pima of montane Chihuahua and Sonora use only a few. Knowledge of the edibility of various fungi is much less widespread among the Mountain Pima than knowledge of plants and was the subject of much more disagreement among native consultants. Most people seem aware that some types are edible, but are apprehensive about the use of fungi as food for fear of poisoning. Most others are considered toxic, including morels *(Morchella angusticeps* Pk.) and puffballs *(Calvatia booniana* A.H. Smith). A few species are regarded as edible by some people but poisonous by others, e.g. *Agaricus campestris* Fr., *Coprinus comatus* (Mull.:Fr.) S.F. Gray, and *Panus strigosus* Berk. & Curt. Only two species are universally regarded as edible, "hongo de maiz" ("corn fungus," i.e. corn smut, *Ustilago zeae* (Beckm.) Unger), and "hongo de comer" ("eating fungus," *Amanita tuza* Guzmán). The latter, distinguished from poisonous species by the pale yellow annulus (Fig. 1), is collected by the bushel from moist pine forests in the area.

FIGURE 1. Hongo de comer *(Amanita tuza).*

Fungi are extremely underclassified among the Pima, with only a few folk species recognized. Fungi are named primarily according to habitat or substrate, being grouped into "hongo de la tierra" ("earth fungus,") "hongo de encino" ("oak fungus,") "hongo de pino" ("pine fungus,") "hongo de fresno" ("ash fungus,") "hongo de sabino" ("cypress fungus,") etc. A fungus growing on the pine shingles of a house is called "hongo de la casa" ("house fungus"). *Cuscuta campestris* Yuncker, a common angiosperm parasitic on herbaceous vegetation, is called "hongo de zacate" ("hay fungus"). All mosses, lichens, and liverworts are lumped together as either "barba de encino" ("oak beard") or "barba de piedra" ("rock beard") except *Selaginella lepidophylla* (Hook. & Grev.) Spring which is "flor de piedra" ("rock flower"). The epiphytic bromeliad *Tillandsia erubescens* Schlecht, however, is called "flor de encino" ("oak flower") regardless of substrate.

The Mountain Pima do acknowledge the existence of unnamed taxa subordinate to the named folk species, and that specimens collected from different substrates represent identical species despite the different names. Occasionally, the native categories cut across the boundaries of scientific classification; for example, specimens of *Panus strigosus* were named as "hongo de encino" when collected from oak (*Quercus* spp.), "hongo de madrono" when found on *Arbutus xalapensis* H.B.K. More often, however, fungi recognized as different species by mycologists are lumped together in heterogenous folk species by the Mountain Pima.

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MINUTES OF THE EXECUTIVE BOARD MEETING SOCIETY OF ETHNOBIOLOGY ST. LOUIS

MARCH 13, 1991

The meeting was called to order by President Wing at 9:00 am in the conference room, Department of Anthropology, Washington University. Board members present were: Wing, Minnis, Timbrook, Pearsall, Fowler and Weber.

SECRETARY/TREASURER'S REPORT

Elections: Fowler announced the results of the election for 1991: Cecil Brown, President Elect; and Robert Bye, Trustee.

Finances: Fowler presented a summary of income and expenditures for 1990, and indicated that the Society seems to be on a better financial footing than a year ago (see report at end of this article). The dues increase has allowed the Society to make an installment payment of $1,050 on the principal owed to Steve Weber ($5 from each regular membership), as well as an interest payment. Outstanding bills remaining for the year are the printing costs for Volume 10, Number 2 of the *Journal,* suggested to be about $5,000. Otherwise, memberships are roughly where they were at this time in 1990, suggesting that the dues increase has probably not caused much in the way of cancellations. If renewals continue to fulfill expectations, the Society should be financially sound for the next few years.

Other financial matters discussed were foreign and domestic postage rate increases, which have indeed cut into the allotment of monies given to Fowler by the University of Nevada, Reno. It was suggested that if postage becomes more of a burden, perhaps those in Mexico and other foreign countries might be mailed their journals once a year unless they wish to pay larger fees. The board did not take action on this, but the situation will be monitored for another year. It was also suggested that Suzanne Fish, an Arizona resident, be asked to be the new resident agent for the Society, replacing Will Van Asdall, and as required by the State of Arizona. Fowler will contact Fish about this task. Fowler also requested that the subscription rates as listed on the inside back cover of the *Journal* be amended to reflect the lower Latin American rate only as voted by the board last year. Presently all foreign subscribers are requesting the $25 rate. A new joint membership rate of $10.00 was also established. Discussed was the suggestion by Carlos Coimbra, review editor for Latin America, that the *Journal* with back issues be sent to libraries in Latin America as a way of stimulating memberships and reviewers. No conclusion was reached, and the Editorial Board was to reconsider the suggestion at its meeting in the afternoon.

At the conclusion of the financial report, Steve Weber offered to begin an endowment for the Society by matching contributions with the dollars still owed to him. Given that the Society had just payed him $1,050, the next $1,050 collected from the dues allotment or specific contributions is to go to the endowment. The next dues notice to members should include an opportunity for matching by Society members. The Board thanked Steve for his generous offer, and for his continued patience in the matter of the debt, and will so proceed.

PRESIDENT'S REPORT

Wing passed around Steve Emslie's NEH proposal for Quincentenary funds to support a plenary session for next year's meeting. The Board fully endorses this proposal, and also other efforts by the host (Bruce Smith, Smithsonian Institution), to seek special travel funds for Latin American and other Third World scholars to attend the conference. The meeting dates have been set as March 25 through 28, in Washington, D.C.

At Wing's request, Minnis reported on the development of a brochure on advertising for the *Journal*. It is ready to send, principally to scholarly presses. The Editorial Board will screen all ads for their appropriateness for the *Journal*.

Various means of increasing Society membership were also discussed. Weber indicated that he still had copies of the original flier on the Society that could be modified and mailed to prospective members. Pearsall was to check and see if the Society could obtain a copy of the membership list of the Society of Economic Botany, as the first target audience. Others discussed going through the *Guide to Anthropology Departments* for potential members that might be targetted. And it was suggested that fliers might be sent to meetings of related scholarly societies. Weber and Fowler will work on an undated flier.

There were four submissions for the Lawrence Award for 1991. Pearsall and Weber were to listen to the presentations and give their evaluatons to Wing who had already read the papers. The award will be announced at the banquet, Friday night. (The winner was Joseph Laferriere.)

The Board voted to give outgoing *Journal* editor Willard Van Asdall a life-time membership in the Society in recognition of all his efforts on its behalf. A letter of thanks and appreciation communicating this is to be sent by the President. Deborah Pearsall will be the new *Journal* editor, beginning with Volume 11, Number 2.

The Board also voted to write a letter to the Director of the San Diego Museum of Natural History, with copies toits board members, indicating how important it is to protect collections by employing trained curators, and deploring the release of curatorial staff, including Amadeo Rea. The letter will come from the Board as a whole, under the signature of the president.

The meeting was adjourned at 12:15 pm.

SOCIETY OF ETHNOBIOLOGY
SECRETARY/TREASURER'S REPORT
March 6, 1991

Date of Last Report: March 5, 1990	
Funds in Account at Last Report	$13,796.28
INCOME SINCE LAST REPORT:	
Sale of back issues of the *Journal*	$ 288.00
Dues: Volume 9	40.00
Volume 10	3,435.00

Volume 11		11,020.10
Life memberships		750.00
Author's Reprints		750.00
1990 Conference Income		230.57
Donations to the Lawrence Fund		200.00
Donations to Smith Fund		50.00
Other Donations		5.00
T-Shirt Sales		464.00
Interest		974.74
Total Income since last report		$18,147.91

EXPENSES SINCE LAST REPORT:

Production of *Journal:*		
Volume 10, Number 1	Typesetting —	$ 1,856.00
	Printing —	4,628.00
	Postage —	*
Volume 10, Number 2	Typesetting —	2,400.00
	Printing —	
	Total —	$ 8,884.00
Other Expenses:		
Interest on Weber loan		420.00
Principal on Weber loan — paid		1,050.00
Lawrence Award		200.00
Shipping back issues, DeKalb to Reno		318.40
Society Stationary		74.37
Book Review editors postage expenses		300.00
Miscellaneous		23.00
Total Expenses		$11,269.77
TOTAL FUNDS IN ACCOUNT AS OF MARCH 6, 1991		$22,229.75

JOURNAL CIRCULATION HISTORY TO DATE SINCE VOLUME 7:

Volume 7	414
Volume 8	439
Volume 9	403
Volume 10	**415
Volume 11	**267

*Postage paid by University of Nevada, Reno.
**Not yet closed out.

NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting recent issues of the *Journal.* If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit manuscripts written in the English language to:

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NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to one of the *Journal's* book review editors. Please see inside front cover for names and addresses.

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EDITOR'S VIEW

There are two views from my desk, around the side of my computer. One is out onto the MU quadrangle. Full of students, squirrels, and, in season, carefully staged plantings. The other is through the oaks, out over the pond on our property. This view reminds me, daily, to be thankful that I have a job to pay mortgages on house and land; even better—a job in my chosen field, ethnobiology. That thought helps keep the escalating problems of academia in their proper perspective.

Today, though, I am thinking mostly of people, people to be thanked and introduced. I know I speak for everyone associated with the Society of Ethnobiology when I thank Will Van Asdall for his years of service to us all as *Journal* editor. I'm happy to say that Will has agreed to stay on as a member of the Editorial Board. Karen Adams, who has served long as an Associate Editor, is also moving to the Board, where she will lend her expertise in paleoethnobotany and the Southwestern United States.

I must also, regretably, announce two resignations. Eugene Hunn, News and Comments Editor, and Gary Nabhan, Board member, have both left the *Journal* staff because of other pressing commitments. They will be missed.

Finally, there are two "draftees" to be thanked: Elizabeth Reitz, for allowing herself to be put on the Editorial Board to help handle a gratifying abundance of zooarchaeological manuscripts, and Christopher Pulliam, for filling in as News and Comments Editor until a permanent replacement can be found. Chris, a veteran of *American Antiquity's* stay at MU, had already volunteered to help copyedit manuscripts.

I come to the job of editor with no agenda. You will see few changes: I think we have a fine journal, and with the help of the editors, the Board, and our reviewers I will work to keep it that way. Remember, though, that the *Journal* is only as strong as the articles we publish. You, the members, are the source of these articles. I am astonished that only two presenters from the 1991 annual meeting submitted papers to the *Journal* for consideration. Feel guilty, the rest of you, and submit your papers before the rush after the 1992 meeting.

So, welcome to volume 11, number 2. I hope everyone finds something of interest here. Any comments or suggestions? Send them to me.

—DMP

Erratum: The title was inadvertently omitted from the short communication by Joseph E. Laferrière appearing in the previous issue of the *Journal,* 11(1):159–160. The title should be "Mountain Pima Ethnomycology."

J. Ethnobiol. 11(2):165–173 Winter 1991

ETHNOBOTANY OF THE SOUTHERN TEPEHUAN OF DURANGO, MEXICO: I. EDIBLE MUSHROOMS

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ABSTRACT.—The Southern Tepehuan is an indigenous group living in the southern part of Durango State and the northern part of Nayarit State in Northwest Mexico. Gathering is still a very important traditional practice among them; in particular reharvestable edible mushrooms are in great demand during the rainy season when they represent an important dietary complement for the people. This paper describes the Tepehuan group, their environment, and how they know and use at least fourteen species of edible fungi. Comments are made with regard to some other edible species of fungi found in the area during the field work as well as to Tepehuan knowledge of poisonous fungi.

RESUMEN.—Los Tepehuanes del sur son un grupo étnico que habita en el sur del Estado de Durango y en el norte del Estado de Nayarit, en el noroeste de México. La recolección es una práctica tradicional entre los tepehuanes; los hongos silvestres comestibles, en particular, tienen una gran demanda durante la época de lluvias, cuando representan un complemento importante en la dieta de esta gente. En este trabajo se hace una semblanza del grupo tepehuano y de su medio ambiente, y se describe como utilizan cuando menos catorce especies de hongos silvestres comestibles. Se hacen comentarios acerca de algunas otras especies comestibles encontradas en el área durante el trabajo de campo y acerca del conocimiento que los tepehuanes tienen de los hongos venenosos.

RÉSUMÉ.—Les Tepehuans du Sud sont un groupe ethnique qui habite au sud-est de l'état de Durango et au nord de l'état de Nayarit au nor-ouest du Mexique. La ceuillette est une pratique traditionnelle très importante parmi les Tepehuans. Les champignons sauvages comestibles y sont particulièrement très demandés pendant la saison des pluies quand ils representent un complement alimentaire important. Dans cet article sont décrits le groupe Tepehuan, son environnement, et son utilisation d'au moins quatorze espèces de champignons sauvages comestibles. Des commentaires sont faits sur les autres espèces comestibles trouvées dans la region lors de cette etude et sur le savoir des Tepehuans sur les champignons vénéneux.

INTRODUCTION

The Northern Mexican mycological flora has been poorly studied in contrast to that of the South of Mexico (Valenzuela 1982). This is especially evident in the State of Durango where recent research has revealed a large number of new

records. Quintos et al. (1984), for example, cite 92 of 100 species included in their paper for the first time for Durango. Perez and Aguirre-Acosta (1985) reported 81 new fungi for Durango in their study, which included 132 species. Both papers are taxonomically oriented; they do not include local information on utilized species. On the other hand, there are no ethnomycological studies for indigenous groups living in the Sierra Madre Occidental in the North of Mexico. Information on this topic is scarce. Pennington (1963) reports the names of eight edible mushrooms in the Tarahumara language, and, in his exhaustive work on the material culture of the Tepehuans of Chihuahua (Pennington 1969), gives the common names of the three main edible mushrooms used by the Northern Tepehuans, *hongo de la tierra* or *hongo rojo, hongo del pino,* and *hongo del encino.* Mares (1982) includes in his work four species of edible mushrooms, *Amanita caesarea (hongo del tiempo de aguas), Ustilago maydis (hongo del maíz),* and two undetermined species, *hongo de temporal* and *hongo blanco de las aguas.*

It is the aim of this paper to present our current knowledge of the edible wild mushroom species used by the Tepehuan people of southern Durango, their harvest times, and methods of preparation. Although not a linguistic study, this work is intended to contribute to the study of Tepehuan ethnobotanical nomenclature by including the Tepehuan name of each species included in this study.[1]

In 1984, when field work was started in the Tepehuan area, it soon became apparent that gathering is still a very important activity among the Tepehuan and that, in particular, reharvestable edible fungi are in great demand during the rainy season.

The Tepehuan diet is limited to several non-irrigated agricultural products such as corn, beans, and squash. This diet is enriched by gathered foods such as roots and other underground plant parts, fruits, greens, by-products and different parts of *Agave* spp., and also various species of mushrooms which play an important role in their diet.

The information presented in this article is part of a comprehensive study of useful wild plants from the Mexican State of Durango. The aim of this research is to make an inventory of all the plants used for food, medicine, building materials, industry, and other purposes.

THE TEPEHUAN AND THEIR ENVIRONMENT

From an ethnographic point of view, the Tepehuan culture from southern Durango has been poorly studied. It is known that Tepehuan is a Uto-Azteca language which belongs to the Piman family (Sanchez 1980) but little is known about the group's past, their prehispanic settlements, or their relationships with other native groups.

The Tepehuan are geographically and linguistically divided into two groups, the northern and southern Tepehuan. The former live in southern Chihuahua and have as neighbors the Tarahumara; the latter live in southern Durango. The southern Tepehuan's closest indigenous neighbors are the Cora and Huichol (Fig. 1). The past relationships between these two Tepehuan groups and the timing of their separation are still controversial matters.

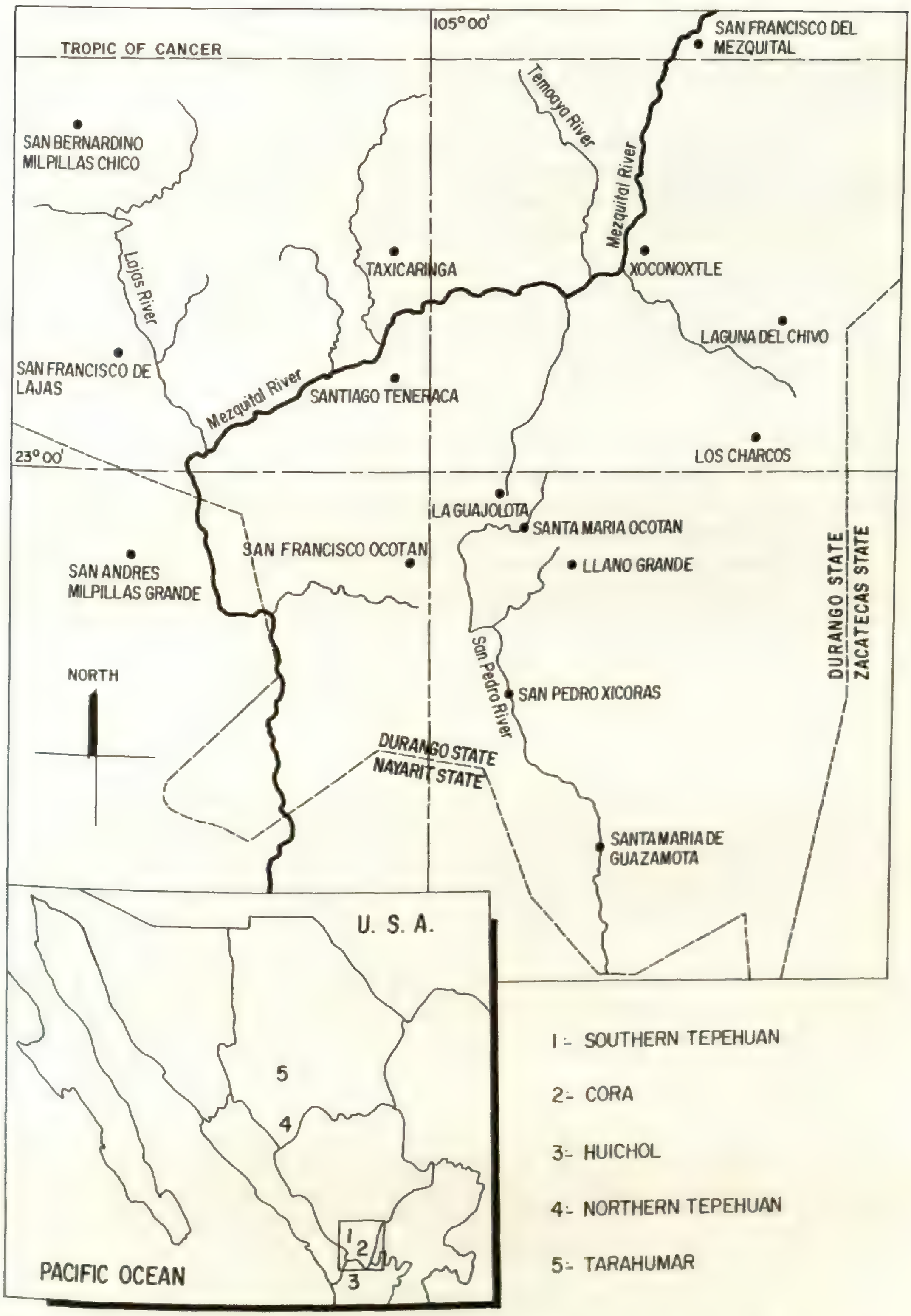

FIG. 1.—Map of southern Durango and northern Nayarit showing the location of indigenous groups and Tepehuan *comunidades* discussed in the text.

Spanish historians assumed that the northern and southern Tepehuans belonged to one group which occupied a large extension of the State of Durango, so they called them *Nación tepehuana* (Sanchez 1980). Rinaldini, in an eighteenth century Jesuit document (Pennington 1969), claims that the Tepehuan spread hundreds of kilometers north and south during the great rebellion in the period between *A.D.* 1616 and 1618. However, Mason (1948) argues, based on language differences, that the separation took place long before the Spaniards arrived.

Today, the southern Tepehuan territory occupies an area of about 9,380 square kilometers in the Sierra Madre of southwestern Durango, extending from 22°20′ to 23°31′ north latitude and from 104°10′ to 105°50′ west longitude. The presence of the majestic Mezquital River canyon and the river tributaries which traverse the zone results in the most rugged topography found in Durango. The altitudinal range is from 600 m at the deepest part of the Mezquital canyon to a maximum of 3,250 m at the top of Cerro Gordo. The ruggedness of the land and the diversity of soils and elevations present result in a variety of vegetation types which include three of the main types of vegetation found in Mexico. These are, according to Rzedowski (1978), Coniferous Forest, *Quercus* Forest, and Tropical Deciduous Forest (Gonzalez 1984).[2]

The southern Tepehuan territory is divided into seven *comunidades:* Santa Maria Ocotan, San Francisco Ocotan, Santiago Teneraca, Santa Maria Magdalena de Taxicaringa (all in the Municipio of Mezquital, Durango), San Bernardino Milpillas Chico, San Francisco de Lajas (all in the Municipio of Pueblo Nuevo, Durango), and San Andres Milpillas Grande (Municipio of Huajicori, Nayarit) (Fig. 1). Each *comunidad* has a political-religious center, several *anexos* (small settlements) and innumerable *rancherias* (one or two family houses isolated from centers of population). Concerning the ownership of land, Santa Maria Ocotan is organized as an *ejido* in which individual members are given the right to exploit individual parcels of land. The rest of the *comunidades* are communally organized. From a linguistic point of view, these *comunidades* also differ; the Mexican Secretary of Public Education (SEP) recognizes three dialects of Tepehuan language (Secretaria de Educación Pública 1986).

Because of the poverty and limited productivity of the land, many of the Tepehuan are forced to leave their communities and work seasonally in the cities, especially during the dry season. Due to this constant movement, it is difficult to determine the exact number of Tepehuan. A recent census made by the SEP reports 25,000 people.

The Tepehuan culture has lost many of its distinctive prehispanic features, such as political and religious organization. However, native language, men's clothing, feasts, and economic activities such as gathering are traditional practices that continue to exist.

MATERIALS AND METHODS

Field work was conducted from 1984 to 1986 in Santa Maria Ocotan, the most important political-religious center of the Tepehuan, and in several of its *anexos:* Llano Grande, Charcos, Laguna del Chivo, and La Guajolota. Sporadic visits were also made to the *comunidades* of San Francisco Ocotan, San Bernardino Milpillas

Chico, Santa Maria Magdalena de Taxicaringa, and San Francisco de Lajas. In each area ethnobotanical information was obtained by interviewing several local informants and on most occasions specimens were collected with the help of these informants.

During interviews, photographs and freshly collected specimens of each mushroom species were shown and the informant asked about the Tepehuan name of the fungus, its edibility, method of preparation, and harvest season. At the same time, informants were asked about other edible fungi and their habitats. This information was then checked through field work.

The freshly collected mushrooms were identified using Guzman (1977), Moser (1983), and Singer (1975). Once dried, specimens were labeled and sent to the ENCB (Herbario, Departamento de Botánica, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Mexico City, D.F., México) where each specimen was examined and determinations confirmed by Ricardo Valenzuela, who is the curator of mycology at this herbarium. Voucher specimens were deposited at the Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional (CIIDIR) Herbarium in Durango city. The species included in this study are illustrated in the taxonomic references cited above or in Von Frieden (1969).

RESULTS

Fourteen species of edible fungi used by the Tepehuan were identified during this study. These are discussed below. The following information is given for each species: scientific name, Tepehuan name (different linguistic forms are given, followed by place of collection), literal translation from Tepehuan into English, habitat, harvest time, form of preparation, and voucher specimen reference, following Bye (1986).

Agaricus campestris L.: Fr. ***kabai pbich*** (Santa Maria O.), "horse excrement"; ***soi nano*** (San Francisco O.) "grasshopper eggs"; ***pbur pbich*** (Lajas and Taxicaringa) "donkey excrement."

This mushroom is harvested after the first rains in May or June. It is common in open, level ground. It is prepared by boiling or roasting over charcoal. M. Gonzalez 1676, CIIDIR.

Amanita caesarea (Scop.: Fr.) Grev. ***jixbi' yakua, jix'uam yakua, jixchua yakua*** (Santa Maria O., San Francisco O.) "red mushroom", "yellow mushroom", "white mushroom"; ***bipi' nakai, jixtata nakai, jix'am nakai*** (Lajas, San Bernardino) "red mushroom", "white mushroom", "yellow mushroom."

This is a well known and preferred mushroom, found in August in humus in pine forests. It has several names in the Tepehuan language according to the color of the pileus, which can be orange, yellow, or very light yellow (red, yellow, and white, respectively, according the Tepehuan people).

The Tepehuan prefer these mushrooms when young and prepare them by roasting over charcoal, boiling, or stewing with pork lard, spiced, and garnished with cheese. M. Gonzalez 1414, CIIDIR.

Hypomyces lactifluorum (Schw.:Fr.) Tulasne. ***nak*** (in most communities) ''ear''; ***pbuchi nak*** (Lajas) ''daughter-in-law ear.''

This is a parasitic fungus on *Russula brevipes, Lactarius salmonicolor,* and *L. deliciosus,* three edible species of mushrooms which it deforms. This is one of the most well-known and preferred mushrooms in this region. It is collected mainly in June and July. It is prepared simply boiled or crushed, stewed with tomato and onion, and garnished with cheese. M. Gonzalez 2014, CIIDIR.

Hygrophoropsis aurantiaca (Wulf.: Fr.) Mre. ***guin'xacan*** (Santa Maria O., Taxicaringa) ''delightful''; ***kia's gio'*** (Taxicaringa, Lajas) ''iguana lard.''

This mushroom is found in humus in pine forests and is harvested from July until September. It is roasted over charcoal or boiled and garnished with cheese. M. Gonzalez 1370, CIIDIR.

Hygrophorus sp. ***gigira'*** (in all communities) ''gathering of people.''

This mushroom is a viscous one with a very light brown and slimy pileus; it grows in July in groups in pine forest humus. It is boiled in salted water. M. Gonzalez 1764, CIIDIR.

Lycoperdon umbrinum Pers. ***kapxia'*** (in all communities) ''ball''; ***ju'ba'pbich nakai*** (Lajas) ''star excrement fungus.''

This fungus is found in moist areas. It is collected in June after the first rains; when young, specimens provide one of the earliest available edible fungi. After slicing it is roasted over charcoal or simply boiled in salted water. M. Gonzalez 1910, CIIDIR.

Macrolepiota procera (Scop.: Fr.) Sing. ***is yakua*** (Santa Maria O., Taxicaringa) ''elbow mushroom''; ***jixtata nakai*** (Lajas) ''white mushroom.''

This mushroom grows mainly in open places in *Quercus* forest in July and August. It can be eaten either roasted over charcoal or stewed. It is preferred stemless and roasted over charcoal. M. Gonzalez 1767, CIIDIR.

Pleurotus spp.

This mushroom grows as a shelf fungus on damp, rotten logs. The Tepehuan distinguish two different species:

P. ostreatus (Jacq.: Fr.) Kumm. ***tasnara*** (in all communities) ''mushroom''; ***tu tuata'mkan nakai*** (Lajas) ''mushroom borne on log''; ***hongo blanco de mayo*** (in all communities) ''white mushroom of May.''

This fungus grows on pine logs, appearing early in the year (i.e., from the middle of April through May). It can be eaten boiled in salted water, crushed or sliced and stewed with spices, or dried in the sun for later consumption. M. Gonzalez 1748, CIIDIR.

P. dryinus (Pers.: Fr.) Kumm., ***tua tasnara*** (in all communities) ''oak mushroom.''

This fungus grows on oak logs. It is harvested in July and prepared the same way as *P. ostreatus,* but it is less appreciated. M. Gonzalez 1773, CIIDIR.

Ramaria spp.

The Tepehuan consume two species:

R. botrytis (Fr.) Rick. ***basik jut*** (Santa Maria O., Taxicaringa) "nail rat."

This fungus grows in groups in pine forest humus. It is gathered in June and July, and prepared boiled in salted water or cooked with cheese. M. Gonzalez 2015a, CIIDIR.

R. flava (Fr.) Quel., ***basik jut*** (Santa Maria O., Taxicaringa) "nail rat"; ***dius nobi nakai*** (Lajas) "God hands mushroom."

This fungus is harvested in July. The Tepehuan prefer it when young and prepare it the same way as *R. botrytis* M. Gonzalez 2015b, CIIDIR.

Russula lepida Fr. ***kurat mo'*** (Santa Maria O., San Francisco O., Taxicaringa) "woodpecker head."

This mushroom grows on pine or oak forest humus. It is gathered in June and July, and is prepared boiled, stewed, or roasted over charcoal. It is not easily discriminated from certain poisonous mushrooms, however, therefore the Tepehuan usually do not use it. M. Gonzalez 1819, CIIDIR.

Rhizopogon sp. ***tora'n*** (Santa Maria O.) "chest"; ***bonkox tora'n*** (Santa Maria O.) "squirrel chest"; ***tur jura'*** (Lajas) "bull heart."

This is an hypogeous fungus found in *Quercus-Pinus* forests. It is gathered in July, and eaten fresh or roasted over charcoal. While Guzman (1977) classifies *Rhizopogon* sp. as a non-edible fungus, the results of this study indicate that the Tepehuans consume it. M. Gonzalez 1931, CIIDIR.

Ustilago maydis (DC.) Corda. ***jaroi*** (Santa Maria O.); ***jura'*** (Taxicaringa) "heart."

This fungus, a parasite on corn cobs, is gathered in August and September. A day before eating it the mushroom is lightly roasted over charcoal, then sliced and crushed together with corn. The next day *atole,* a thick beverage, is prepared with this mixture. M. Gonzalez 2066, CIIDIR.

DISCUSSION

It appears that most Tepehuan know and use at least five of the 14 mushrooms discussed above: *Agaricus campestris, Amanita caesarea, Hypomyces lactifluorum, Pleurotus ostreatus,* and *Ustilago maydis.*

In addition to the 14 fungi listed above some informants also gave information about another edible mushroom which was not found during field work. Based on their descriptions and identifications from photographs it seems probable that this mushroom, *Sparassis crispa* Fr., also grows in this zone. The Tepehuan names for this fungus are ***boka'n*** "cow rumen"; ***basik nak*** "rat ear"; and ***bonkox nanak*** "squirrel ears". It is prepared boiled in salted water or stewed with cheese, onion, and tomato. It is also sun-dried for later consumption.

Concerning poisonous mushrooms found in this zone, the Tepehuan identify *Amanita muscaria* (L.: Fr.) Hook. and *A. pantherina* (DC.: Fr.) Krombh., both called ***tirok yakua*** "lagarto mushroom" or "scraping mushroom", because of "warts" on the cap. The Tepehuan use the word ***maimda'kam*** as a generic term to refer to those poisonous mushrooms that make people feel dizzy or drunk.

Although other known edible mushrooms such as *Boletus edulis* Bull.: Fr. and *Boletus pinicola* Vitt. were observed in the area, the Tepehuan do not gather them. They are considered animal food since cows eat them. However, it is also possible that the number of mushrooms used for human food has decreased in recent years.

Gathering is an important activity throughout the year, and it is a very popular and rewarding activity during the rainy season. Edible mushrooms still play an important role in Tepehuan diet in spite of the introduction of canned and processed foods in the remote communities of the Sierra Madre Occidental. Gathering is practiced mainly among the older generation; nevertheless, young people are also familiar with the most common mushrooms and include them in their diet. To a certain extent it is true that knowledge about the use of edible mushrooms is being lost due to modernization of the younger Tepehuan, but it is also true that changes to habitats preferred by mushrooms have made these resources less available.

CONCLUSIONS

Wild edible mushrooms represent a dietary complement for the Tepehuan, especially during the rainy season. Fourteen edible mushroom species are discussed in this paper. *Agaricus campestris, Amanita caesarea, Hypomyces lactifluorum, Pleurotus ostreatus,* and *Ustilago maydis* are the most preferred among the Tepehuan. One species which was not collected during field work (probably *Sparassis crispa)* is also very much appreciated by this indigenous group. Roasting over charcoal and boiling are the most common methods of preparing fungus among the Tepehuans.

Rhizopogon sp. and *Ustilago maydis* were newly registered for the mycological flora of the State of Durango. The former is recorded for the first time as an edible fungus; the latter is prepared in a unique way not documented before (i.e. *atole).*

NOTES

[1]The transcription system of the Tepehuan language elaborated by the Secretary of Public Education of Mexico is here used. The inventory of the symbols includes the vowels ***a, e, ɨ, i, í, o, u,*** and the consonants ***b, ch, d, dy, g j, k, l, hl, m, n, ñ, p, pb, r, s, t, x, y, ′***. Word stress is most often on the first syllable.

[2]Translation by the author.

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Aztec Medicine, Health, and Nutrition. Bernard R. Ortiz de Montellano. New Brunswick, NJ and London: Rutgers University Press, 1990. Pp. xvi, 308. 2 maps, 19 illustrations, 24 tables. ISBN 0–8135–1562–9. $40.00 (Hardcover), $15.00 (Paper).

The knowledge of bioactive properties of the varied flora of Mexico was extraordinarily well developed. In fact, the Aztec possessed undoubtedly a wider and probably a much more practical ethnopharmacological acquaintance with their flora than their conquerors had of the plants of Europe. Their interest went far beyond the presumed medicinal value of plants and included ideas concerning nutrition and health in general.

It is fortunate that amongst the Spanish conquerors there were a few individuals whose educational level permitted them to show an interest in native life and customs and an intrinsic interest in what the conquered society could offer. It is to these men that we owe much of our present knowledge of the great civilization of Mexico. Many of these men were ecclesiastics such as Sahagún, but perhaps the best prepared chronicler was Dr. Francisco Hernandez, personal physician to the King of Spain, who was sent to study over a period of several years the medicinal plants of the Aztecs.

Dr. Ortiz de Montellano has published a masterly treatise on the medicine and ideas of nutrition and health of the Aztec. I cannot recall any volume so thoroughly inclusive of this most significant ethnopharmacological aspect of the great civilization that was all but destroyed by the Spanish invaders. Ortiz has not only faithfully searched documents written by Sahagún, Hernandez, and others, but has reported the Aztec monuments, paintings, and other archaeological remains and has given us the interpretation of their message concerning medical, health, and nutritional beliefs.

The book is profusely illustrated. There are eight chapters: 1) Aztec culture; 2) Aztec religion; 3) Population and carrying power of Mexico's basin; 4) Diet and food sources; 5) Epidemiology; 6) Diagnosing and ideas of illness; 7) Curing; and 8) Syncretism in Mexican folk–medicine. The two appendices discuss nutritional values and amino acid content of Aztec medicinal plants. There follow six pages of detailed notes, 25 pages of bibliography, and a detailed index of 15 pages that makes it easy for the reader to find the wealth of interdisciplinary information presented in the book.

Ortiz is to be highly complemented; many investigators will thank him for such a valuable contribution to historical ethnobotany. And we shall all be grateful to the Rutgers University Press for publishing in a paperback edition such a significant piece of research.

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HUNTING, USE, AND KNOWLEDGE OF THE BIOLOGY OF THE WHITE-TAILED DEER *(Odocoileus virginianus Hays)* BY THE MAYA OF CENTRAL YUCATAN, MEXICO

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ABSTRACT.—We present an account of different deer hunting techniques used by the Maya of Tixcacaltuyub, Yucatan, Mexico. The *batida,* or drive hunt, is highly favored at present. When a deer is shot, the person who actually killed it has the privilege of looking for the ***Tunich*** (a small good luck stone found sometimes in the stomach), and taking the right leg, the head, the stomach, and the liver. The rest is divided among other party members. Deer are shared with the whole village only when hunting is associated with a religious celebration (i.e., ***Ch'a' Chaak***). We present a list of plant species, both cultivated in *milpas* and part of the native vegetation, that form the diet of deer in the area, and an account of the knowledge hunters have of deer biology. Finally, we discuss the decrease in deer population densities and the importance of implementing a vegetation management program that balances the amount of land with young and mature forest vegetation and that dedicated to agriculture, in order to have a mosaic that will satisfy the nutritional and other requirements of deer.

RESUMEN.—Presentamos una reseña de diferentes técnicas para cazar venados usadas por los mayas de Tixcacaltuyub, Yucatán, México. La batida, o cacería en grupo, es actualmente un método favorito. Cuando un venado es cazado, la persona que lo mató tiene el privilegio de buscar el ***tunich*** (una piedra pequeña de buena suerta, encontrada a veces en el estómago), y el derecho a una pierna, la cabeza, el estómago y el hígado; el resto se reparte entre los otros miembros de la batida. Los venados se comparten con toda la comunidad unicamente cuando la caza esta relacionada con una festividad religiosa (por ejemplo el ***ch'a' chaak***). Presentamos una lista de las especies de plantas, ya sea cultivadas en las milpas o parte de la vegetación natural, que forman la dieta básica del venado en la zona, y un resumen del conocimiento que tienen los cazadores de la biología del venado. Finalmente, discutimos la disminución en la densidad de población del venado y la importancia de implementar un programa de manejo de la vegetación que mantenga un balance entre la extensión de terreno con bosque joven y maduro, y el área dedicada a la agricultura, de tal manera que se tenga un mosaico que satisfaga los requerimientos nutricionales, entre otros, del venado.

RÉSUMÉ.—Nous présentons différentes techniques utilisées par les Mayas de Tixcacaltuyub de Yucatán au Mexique. La *batida*, ou chasse en groupe, est la méthode preférée actuellement. Quand un daim est tué, le chasseur qui l'a abattu a le privilegè de chercher le ***Tunich*** (une petite pierre qui porte chance qui se trouve parfois dans l'estomac), et droit à une jambe, la tête, l'estomac, et le foie; le reste est réparti entre les autres chasseurs. La seule occasion où un daim est partagé avec le reste des habitants de la communauté est lorsque la chasse est liée à une fête religeuse (par example ***Ch'a' Chaak***). Nous présentons une liste des plantes, soit cultivées dans les *milpas,* soit élèments de la végétation naturelle, qui correspond à l'alimentation du daim dans la région, et une description du savoir élémentaire des chasseurs sur la biologie des daims. Finalement, nous abordons la diminution de densité de la population des daims et l'importance de la mise en place d'un programme de gestion de la végétation qui maintienne un équilibre entre la quantité du territoire dédié aux activités agricoles et celui couvert de végétation jeune et relativement mûre, afin de satisfaire les exigences d'alimentation et de reproduction des daims.

INTRODUCTION

Deer have been exploited by the Maya since pre-Hispanic times (Cibeira 1977; Freidel 1978; Landa 1982; Morley 1965). Even though deer population densities have declined dramatically in the Yucatan Peninsula due to excessive hunting and habitat destruction (Carrillo 1987; Hernández et al. 1974; Leopold 1965), and hunting is now banned, deer remain an important source of animal protein for the Maya (Carrillo 1987; Gaumer 1917; Redfield and Villa-Rojas 1934; Yah 1983). Two species of deer inhabit the Yucatan Peninsula, the white-tailed deer or ***Keej*** *(Odocoileus virginianus* Hays), and the brocket deer or ***Yuk*** *(Mazama americana* Merriam) (Hall 1981). Yucatecan Maya prefer ***Keej*** because they are larger and their meat tastes better. In this paper we describe the hunting methods and exploitation of the white-tailed deer by the inhabitants of a rural Mayan community in central Yucatan, Mexico. We also present an account of the hunters' knowledge of deer biology and a list of plant species that form the diet of deer in the area.

STUDY AREA AND METHOD

Fieldwork was done in the Mayan community of Tixcacaltuyub, Yucatan, Mexico (20°27′ N, 88°59′ W; 18-24 m elevation). Climate is warm, subhumid, with a dry season in winter and early spring and a rainy season between June and October. Mean annual temperature is 27.5°C and total annual precipitation is 900-1,000 mm. As in the rest of Yucatan, the Tixcacaltuyub area is relatively flat, with no rivers, and surface soil is scarce or lacking, with many exposed limestone outcrops. Most land is dedicated to *milpas,* mixed fields of corn, beans, and several species of squashes, or cattle raising. The vegetation of this region is described by Miranda (1958) as a variety of tropical deciduous forest *(selva mediana subdecidua)* with canopy height at 25–30 m. Present-day vegetation is a mosaic of young successional stages (i.e., 1–20 years of abandonment) dominated by a mixture

of species from the deciduous and dry tropical forests that dominate the northern portion of the Yucatan Peninsula (Rico-Gray and Garcia-Franco 1991b). Only minimal areas, confined to private ranches, are covered by forests with some resemblance to the original vegetation (Rico-Gray et al. 1988b). A recent vegetation survey in the area (Rico-Gray and Garcia-Franco 1991b) reports in most regrowth stages the presence of the following shrub and tree species: *Acacia* sp., *Apoplanesia paniculata* Presl., *Bunchosia swartziana* Griseb., *Bursera simaruba* (L.) Sarg., *Caesalpinia gaumeri* Greenm., *Cnidoscolus aconitifolius* (Mill.) I.M. Johnston, *Cordia gerascanthus* L., *Croton glabellus* L., *Diospyros anisandra* Blake, *D. cuneata* Standl., *D. verae-crucis* (Standl.) Standl., *Eugenia mayana* Standl., *Gliricidia sepium* (Jacq.) Steud., *Gymnopodium floribundum* Rolfe, *Hampea trilobata* Standl., *Jatropha gaumeri* Greenm., *Lysiloma latisiliquum* (L.) Benth., *Machaonia lindeniana* Baillon, *Neomillspaughia emarginata* (Gross.) Blake, *Piscidia piscipula* (L.) Sarg., and *Pithecellobium albicans* (Kunth.) Benth. Ten of these species account for more than 50% of the total of relative importance value per regrowth year, but each regrowth year is dominated by different species, for example: Year 10, *N. emarginata, Helicteres baruensis* Jacq., *Gymnopodium floribundum, L. latisiliquum, Mimosa bahamensis* Benth.; Year 15, *Pithecellobium albicans, L. latisiliquum, Bursera simaruba, G. floribundum, Croton glabellus;* Year 30, *B. simaruba, G. floribundum, E. mayana, L. latisiliquum, N. emarginata;* Year 40, *E. mayana, B. simaruba, Caesalpinia gaumeri, G. floribundum, N. emarginata;* Year 100, *G. floribundum, Vitex gaumeri* Greenm., *B. simaruba, Psidium sartorianum* (Berg.) Niedenzu, *Bunchosia swartziana.*[1] Most of these species regenerate from coppiced shoots.

Fieldwork was done in March and August, 1988. Information was obtained through open interviews with 11 Mayan peasants who were dedicated to subsistence hunting. Interviews were complemented with field observations aimed at recognizing some of the plant species used for food by deer.[2] We examined recent deer trails and assessed the damage deer browsing had caused to plants along the trails.

RESULTS

Deer hunting.—Deer hunting is a male activity. There are approximately 50 hunters in the village of 250 families. Hunting takes place year round, but the dry season, November through May, is preferred because the trees and many shrubs have shed their leaves and animals are easier to see. The dry season is also a time of low activity for farmers in the corn fields. Deer are hard to find at present, and as a rule Tixcacaltuyub hunters shoot only one animal per hunting trip. In other Yucatecan communities, such as Xul, four or five animals may be shot per hunting trip, and usually two hunting trips are made per month (Sanabria 1986). This difference is the result of there being more deer in those areas. One of the best hunters in Tixcacaltuyub had killed six animals (four ***Keej*** and two ***Yuk)*** between January and August, 1988, while another hunter shot four during the same period. Other hunters may not kill an animal for years, even though they try. The number of animals killed varies from year to year as a result of hunting ability, weather, and condition of vegetation. There were, for example, only 20 deer ***(Keej)*** killed in Tixcacaltuyub during 1987. The main motivation for hunting is the lack of

enough money to buy meat such as pork. Other motives include having had very good luck before, enjoyment of hunting, and for celebrations. Deer hunters have two basic objectives: (1) to find and possess the *virtud* (virtue, ability, good luck) to hunt more deer, and (2) to obtain animal protein.

It is believed that *virtud* is obtained from killing a deer with a small tusk or a small stone, or ***Tunich***, in its stomach. The person who shoots the deer, even though he may be hunting in a group, retires with the catch, opens the stomach of the animal, and looks for the ***Tunich***. If the ***Tunich*** is found, he takes it, keeps it for himself, and hides it in a secure place. The ***Tunich*** has to be carried whenever he goes hunting. After a certain period of time, it is better to return the ***Tunich*** to the deer (i.e., leave the stone in the forest), because it may be harmful to the hunter if kept for a long time.

Based on the information obtained through interviews in Tixcacaltuyub, deer hunting is accomplished using five methods:

(1) *Batida* (drive hunting or group hunting). This method has been used by the Maya since pre-Hispanic times (Landa 1982), and it is often used today in Tixcacaltuyub, as well as in other communities (Arias and Hernández X. 1981; Redfield and Villa-Rojas 1934; Sanabria 1986; Yah 1983). Hunting by this method takes place during the day. Four to eight hunters (sometimes 20) and 12 to 18 trained dogs take part. *Batida* consists of selecting and surrounding 4,000 to 8,000 square meters of a ***Hubché*** (a certain vegetation successional stage; see below) where a deer has been spotted. The hunters form a semicircle, taking positions every 60 to 80 m, and wait. One or two hunters then enter the ***Hubché*** with the dogs and drive the deer towards the hunters forming the circle, who shoot at it.

(2) *Acecho* (stalk). This method was also used by the pre-Hispanic Maya (Gaumer 1917; Landa 1982), but due to its difficulty it is seldom used today in Tixcacaltuyub. *Acecho* is based on in depth knowledge of the habits and movements of deer. This was an easier method to use when deer were more abundant, but present scarcity almost prohibits its use. During the day this method is carried out by an individual hunter, without the help of dogs. The deer is tracked and shot if found. A slightly different version of this method is when the hunter uses a call (e.g., the call of fawn to mother, female to male, or of a scared animal) to attract the deer after it has been located. The call is made with the help of the hunter's hands, nose, and mouth, or by using a special whistle.

(3) *Espera* (wait). Basically, one to three hunters climb neighboring trees strategically located near a corn field (*milpa)* or a water source (***haltún*** or *sarteneja,* see Flores 1983), and wait for deer to appear. The *espera* is accomplished either during the day or night, but preferably at sundown or sunrise.

(4) *Lampareo* (light-spotting, use of a light source). This is an active hunting method; deer are searched for by night with the use of a light source at specific sites in the forest or where deer trails enter the *milpas.* This method has been commonly used in Mexico; its use has helped to decrease deer populations severely (Leopold 1965).

(5) *Sorpresa* (surprise). In general, deer hunting is a conscious decision; hunters get together and plan hunting trips. Nevertheless, most peasants carry their rifles when working in their *milpas;* a deer may be encountered in the corn field during the day and killed without an organized hunting trip.

Once a deer has been killed, it is carried back to Tixcacaltuyub and divided among the hunters. The person who actually killed the deer has the right, by tradition, to one leg, the head, the stomach, and the liver. The liver is highly appreciated. In other Yucatecan communities a hunted deer is divided in the same way (Yah 1983). An adult male deer may yield up to 35 kg of boneless meat, while a young animal or an adult female yields about 25 kg. Meat and entrails are sold in the village (2.50 USCY per kilogram) or consumed by the family. Venison is used to prepare ***Pibil*** or ***Pib*** *(asado),* ***Chokmole,*** *salada, ahumada, pipian, and* ***Tzik*** *(salpicón)* (see Ucan Ek et al. 1983 for some Yucatecan recipes). Bones, stomach contents, and intestines are offered to the dogs and pigs. The scrotum may be transformed into a bag. Skin is sold at 0.50 USCY per kilogram; the hunters may obtain up to 4 kg of skin from a large animal. Antlers may be used as cloth hangers or to shell corn. Venison is not marketed to the state capitol, Merida, where it can bring up to 6.00 USCY per kilogram.

The only time a hunted animal is shared with other village inhabitants is when hunting is part of festivity, like the ***Ch'a' Chaak*** ceremony or worship to the rain god ***Chaak***. Historians report that the ancient Maya also used venison in their religious ceremonies or as tribute (Landa 1982; Morley 1965).

Other mammals hunted by the Maya of Tixcacaltuyub are *temazate* or ***Yuk*** *(Mazama americana* Merriam), *Pecarí de collar* or ***Kitsitam*** *(Tayassu tajacu* Merriam), *conejo (Sylvilagus floridanus* Miller), *armadillo* or ***Wesh*** *(Dasypus novemcinctus* Peters), *tepezcuintle* or ***Jaleb*** (*Agouti paca* Goldman), and *tejón* or ***Ekpay*** *(Nasua nasua* J.A. Allen). Birds are also hunted; the most important species are *pavo de monte (Agriocharis ocellata* Cuvier), *chachalaca (Ortalis vetula* Wagler), and *codorniz* and *perdiz,* two Phasianidae.

Hunter knowledge of deer biology.—The following account is a description of different aspects of deer biology known to the hunters of Tixcacaltuyub. White-tailed deer ***(Keej)*** are given different names according to age, antler characteristics, size, and hair color (Table 1); sex is not differenciated.

The Maya classify vegetation in a complex and accurate way (Flores and Ucán Ek 1983; Sanabria 1986). The basic division is between young forest *(monte bajo)* and old forest *(monte alto),* each with subdivisions based on time elapsed since previous use. This classification may vary slightly among different communities (Paulino Simá, personal communication, 1988). ***Keej*** are found both in young and old forests, but prefer the former because they find more food and protection against insects. Vegetation types used by deer are ***Kabal hubché*** (2-10 years since previous use), ***Tankel hubché*** (10-20 years), ***Yax k'aax*** (20-30 years), ***Nukuch k'aax*** (more than 40 years), and *milpas.* Deer prefer the young forest, particularly the ***Kabal hubché***, because there is more food and more places to sleep and raise their young. Deer mate and young are born in the ***Kabal hubché***. Old forests are used less than young forests; they are used for shade and feeding. Deer feed primarily in the early morning (4:00-7:00 A.M.) and evening (6:00 P.M. to 1:00 A.M.); they do not eat just any plants, preferring leaves and tender shoots. Hunters consider them to be delicate eaters. Deer also feed in the *milpas.* The *milpa* is preferred in August (rainy season), because after the vegetation has been felled and burned for new *milpas,* rain triggers resprouting from coppiced trunks. Deer prefer

TABLE 1.—Names used by the hunters of Tixcacaltuyub, Yucatan, Mexico, to refer to deer of different ages and characteristics.

Local Name	Description
Keej	White-tailed deer
Yalem keej	Fawn
Tankelem keej	Yearling
Nojoch keej	Adult
Jaabenté	Young male with first antlers
Putsna ab	Male with one point per antler
Kaak jeek'	Male with two points per antler
Oox jeek'	Male with three points per antler
Kankan jeek'	Male with four points per antler
Cacao bak	Male with very small wide-based antlers, similar to Cacao fruit
Tzo ots bak	Male with velvety antlers
Yaax nik	Large males/females with green-black hair
Rojos	Small males/females with reddish hair, but not the color of ***Yuk***

these tender leaves and shoots, particularly *Neomillspaughia emarginata* ***(Saj iitsá)*** and *Gymnopodium floribundum* ***(Ts'iits'il ché)***. Hunters say that deer do not eat growing corn; this contradicts some published reports (Leopold 1965; Sanabria 1986). Deer only drink water during the dry season, when they use *sartenejas,* small, natural holes or depressions in the rock which fill with rain water (see Flores 1983 for a detailed description of *sartenejas)*. Deer obtain water by feeding on succulents and vegetation wet from morning dew.

Plant species used for food by deer.—The hunters of Tixcacaltuyub consider that the following plant species form the basic diet of deer in the area: *Abutilon gaumeri* Standl. (***Ya'ax jool***; secondary growth, leaf), *Bursera simaruba* (L.) Sarg. (***Chakaj***; secondary growth and mature forest, leaf), *Caesalpinia violacea* (Miller) Standl. (***Chakte'***; secondary growth and mature forest, leaf), *Capsicum* spp. (*chiles; milpa,* leaf and young fruit), *Chochlospermum vitifolium* Willd. ex Spreng. (***Chu'um***; secondary growth and mature forest, leaf), *Colubrina greggii* S. Watson (***Churumay***; secondary growth, leaf), Cucurbitaceae (a number of species; *milpa,* leaf and young fruit), *Eugenia axillaris* (Swartz) Willd. (***Kiis yuuk***; mainly secondary growth, leaf), *Gymnopodium floribundum* Rolfe (***Ts'iits'il ché***; secondary growth and *milpa,* tender leaves and shoots), *Ipomoea batatas* (L.) Poir. (*camote; milpa,* leaf), *Jacquemontia pentantha* (Jacq.) G. Don (***Izakil camote***; young secondary growth, leaf in dry season), *Merremia aegyptia* (L.) Urban (***Tso' ots k'ab***; young secondary growth, leaf), *Metopium brownei* (Jacq.) Urban (***Chechem***; secondary growth and mature forest, fruit), *Neomillspaughia emarginata* (Gross.) Blake (***Sajiitsá***; secondary growth

and *milpa,* tender leaves and shoots), *Pachyrrhizus erosus* (L.) Urban *(jicama; milpa,* leaf), *Phaseolus* spp. ***(Iibes****; milpa,* leaf), *Quamoclit coccinea* (L.) Moench (***Chak lool****;* young secondary growth, leaf), *Salvia coccinea* Juss. ex Murr. (***Chak tsits****;* young secondary growth, leaf), and *Viguiera dentata* (Cav.) Spreng (***Taj'****;* young secondary growth, leaf). Captive fawns are fed sheep or goat's milk; yearlings and adults are fed leaves of *Brosimum alicastrum* Swartz (***Ox***), corn (grain, *tortilla, masa),* or leaves of plants brought from the field.

DISCUSSION

Venison has traditionally been an important source of animal protein in the diet of the Yucatecan Maya. However, deer hunting was banned in the Yucatan Peninsula in April 1987; this law prohibits hunting, marketing, and selling venison in restaurants. As shown by the results of this study, this law is not respected by peasants in small villages. Is prohibition of hunting the best way to increase deer population densities in the Yucatan? One of the oldest Mayan hunters interviewed expressed this view: ''In the past, one could choose the quarry with great care, you only shot the big males, never the young or females. At present, even the young and females are killed, if this goes on they will vanish. As time passes the animals are more scarce, there are more hunters, and less appropriate areas to look for deer. If hunting was stopped for four or five years, we will once again have deer for everyone.'' We consider that the main causes for the decrease in deer population numbers are habitat destruction and hunting for commercial trade; subsistence hunting by the Maya was not a real threat in the past. At present, excessive subsistence hunting coupled with an increase in areas lacking natural vegetation or in early regrowth stage (1–6 years) relative to areas with more mature forest (40–60 years) may be a threat to deer populations.

The vegetation of the Yucatan Peninsula has been cleared by man for a variety of purposes (e.g., logging, cattle raising, sisal and orchard plantations), dramatically modifying the natural habitat of deer. Modification of mature forest communities has both positive and negative effects on deer populations: (1) young secondary growth and *milpas* create ideal feeding habitats for deer, because many plant species resprout after slash-and-burn practices, providing readily accessible and palatable feed, and (2) deer need more mature vegetation for resting, mating, and raising their young. If the Yucatecan forests were under a management system that would allow the Maya to exploit while conserving, then there would be no need to worry about deer scarcity. This program should consider the establishment and maintenance of areas with both young and old vegetation, a mosaic to satisfy fully the nutritional and other requirements of deer (Rico-Gray et al. 1991). The Maya have developed and used a variety of agro–silvicultural techniques, which have formed the basis of their vegetation management system (Chemás and Rico-Gray 1991; Gómez-Pompa 1987a, 1987b; Gómez-Pompa et al. 1987; Rico-Gray and García-Franco 1991a; Rico-Gray et al. 1985, 1988a, 1988b, 1990, 1991). The careful study and adaptation of these techniques to modern needs should be attempted to make a better use of our natural resources. Of particular interest should be the study of the interaction between traditional forest manage-

ment, its effect on deer populations, and the economic and cultural factors that promote deer hunting among the Maya.

NOTES

[1]Relative importance value is an ecological measure, the sum of the relative frequency, relative abundance, and relative dominance for each species.

[2]Plant names (Maya, Spanish, and Latin) follow Sosa et al. (1985). Vouchers by different collectors (C. Chan, J.S. Flores, J.A. Gutiérrez, R. Lira, M. Narváez, A. Puch, Paulino Simá, Pedro Simá, E. Ucán Ek, C. Vargas, P. Yam) are deposited at ***XAL*** (Herbario, Instituto de Ecología, Xalapa, Veracruz, México) and ***YUC*** (Herbario, Centro de Recursos Bióticos de la Península de Yucatán, Mérida, Yucatán, México).

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BOOK REVIEW

The Potato: Evolution, Biodiversity, and Genetic Resources. J.G. Hawkes. London: Belhaven Press, 1990. Pp. viii, 259. Photographs, maps, and a line drawing of floral parts. $48.00. ISBN 87474–465–2.

Of all the gifts of the Andean chain to the world tobacco and the potato stand out as undoubtedly the most widely used economic plants. It is difficult to imagine life in North America and Europe without the potato. Great advances

have been made in potato production and other aspects of biology of this crop plant, but modern techniques certainly can promise even more improvements if wild strains and related wild species are preserved.

The present study by one of the outstanding experts on the potato (an up-dating of his earlier publication on the botany of the potato) is a concise but searching summary of potato history, classification, nomenclature, and biology. It appears at a very opportune time, when conservation and biodiversity have come to the fore in the public mind. The Andean flora still offers material that may be of extreme value to future breeders and scientists.

The book has seven chapters. The introduction summarizes the importance of the potato as a world crop and briefly reviews related and cultivated species, diversity of wild types, and the prehistory and introduction of the potato to Europe. Chapter 2 discusses the origin and first home of the potato, and the third chapter surveys its spread the world around. In Chapter 4 the cytology and reproductive biology are considered. Chapter 5 is devoted to evolution of the plant. In Chapter 6 systematics and biodiversity are outlined with 220 species discussed, and descriptions and keys presented. This is followed by consideration of the genetic resources of the potato in Chapter 7.

There are four appendices: 1) Names not included in this volume; 2) Classification, biology, and geographical origin of species in *Solanum,* section *Petota;* 3) Glossary; and 4) Taxonomic list of names and their usual abbreviations.

The bibliography comprises 148 items. It is followed by a comprehensive index.

Economic and systematic botanists, biochemists, geneticists, agriculturists, phytopathologists, breeders, and students of history will find this contribution a welcome summary of a most complex but challenging biological exercise of such importance to human development.

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BOOK REVIEW

With Bitter Herbs They Shall Eat It: Chemical Ecology and the Origins of Human Diet and Medicine. Timothy Johns. Tucson: University of Arizona Press, 1990. Pp. xviii, 356. Plates, maps, appendices, bibliography, index. ISBN 0-8165-1023-7. $40.00.

In this major study, Timothy Johns advances the state of ethnobiological thinking on the role of biochemistry in human-plant interactions. Discussing the omnivorous nature of our species, he shows how we have had to draw on our intellectual resources to construct cultural ways of dealing with the complex and varied chemicals in our foods. Humans have specific nutritional needs and are subject, to varying degrees, to poisoning by a wide range of chemicals naturally

occurring in plants. Often highly nutritious plants are also highly toxic, since they have the most need to protect themselves from herbivores (such as ourselves). Thus, we, like all mammals, have to know enough to eat what is good for us and to cope with the dangers. It is the process of coping that concerns Dr. Johns. Humans must detoxicate (removing poisons by physical means) or detoxify (removing poisons by chemically destroying them) many important foods before eating, to get the maximum benefit from them.

Johns's research was in the area of Lake Titicaca, where he studied the Aymara and their use of various potato species and hybrids. Most of these were rich in glycoalkaloids and other toxic chemicals. These can be dealt with by making *chũno* of the potatoes, or by eating them with an absorbent clay. Selection for innoculous strains is evident, but can go only so far, because of a need to hybridize cultivated potatoes with wild strains that are highly resistant to local environmental stresses.

Such observations led Johns into a deep and wide-ranging enquiry on the role of potentially toxic biochemicals in human evolution and culture. His scope is so broad that it defies summary here. Even so apparently simple a question as that of human taste leads him into an exploration that deals with why some of us cannot taste PTC; comparative taste vocabularies in different languages; whether humans have only four tastes (he follows the skeptical line on this debated issue); or, why we can detect and avoid some poisons but not others. We even learn why owl monkeys love sour things; here, as elsewhere in the book, Johns's arguments benefit from primate comparisons.

Johns finds that the needs of an omnivorous diet, in which plants played a large part, has conditioned our evolution: gut length and structure, enzyme array, taste sensitivity, and nutritional needs. He discusses the ways in which early humans could have detoxicated and detoxified their foods, such as pressing out juice, drying, fermenting, or mixing with acid or alkali. He finds cooking would not have been very effective for these purposes, especially until watertight vessels made boiling practicable. (Here one might wish he had addressed the worldwide importance of ash-baking and earth ovens—surely ancient and surely relevant here.) In tables and appendices he provides a vast array of data on such processing methods and what plants undergo what processes in simpler societies.

He argues for an important role of chemistry in early domestication. Many plants became foci of attention because they were nontoxic. Others became foci precisely because they were toxic. Some, like the potatoes, were bred for lower toxicity. Some—and this is important—were bred to have more, either for pest-control reasons (as in the case of manioc) or because the poisons were what people wanted (as in the case of tobacco). Either way, domestication has been a matter of breeding plants for a different chemistry—not just for the classic "higher yields" or ease in harvesting.

Ancient medicine was, of course, even more obviously involved in phytochemistry. Johns reviews the impressive array of new evidence that chimpanzees and even moneys use herbal medicines. Surely, human progress has been, in part, a history of increasing knowledge of the values of medicinal plants. Worm-killing, for instance, is easy to see; it requires no sophisticated laboratory.

Thus, archaic societies, and even apparently chimpanzees, know vermifuges. As in the other parts of the book, Johns provides a rich review of the cross-cultural and historical data on medicinal plant use. It reveals that humans have slowly incorporated more and more knowledge of both real and imagined medical values of plants into their cultural repertories.

Johns is at his best when he brings together many different bodies of literature in order to make one point. He integrates chemistry, taste physiology, and food psychology in his study of taste; crop evolution, chemical ecology, and archaeology in his observations on human evolution; and so throughout. He displays a profound knowledge of different literature and a wonderful contempt for the artificial limitations of academic disciplines.

Such an ambitious undertaking must have a few flaws; among errors or slight misstatements that could confuse the reader: P. 12: "Domesticates, in face, are the only plants that reflect detectable evolutionary change during the last ten thousand years." This is debatable, and in regard to weeds it is quite misleading. P. 102: early domestication is seen as "natural selection" rather than "artificial selection;" John's point is that it was not an entirely controlled process. True, but "artificial selection" it must remain, by the dictionary definitions, and by common logic: we never completely control any biological process. P. 232: " ... many plant foods lack certain amino acids [necessary for humans]": a common error, but actually almost all usual plant foods have all the necessary eight amino acids; the problem is in the proportions, not the absolute presence or absence. P. 283: *Chenopodium ambrosioides* is glossed as "wormwood"; it is usually "wormseed," with "wormwood" being used for *Artemisia* species. If this is a local usage, it might have been explained.

In many ways, this book is reminiscent of the great biological works of the nineteenth century. Beginning with a simple and humble phenomenon—Bolivian Indians dipping their meagre supper of potatoes in clay—Johns shows how an understanding of this behavior must draw on the wide field of human knowledge of plants. He reaches a broad and original view of human-plant interactions throughout hominid evolution. He has thus contributed to the integration of ethnobiology and biochemistry and nutritional physiology—a focus advanced by such scholars as Nina Etkin and Harriet Kuhnlein.

With Bitter Herbs They Shall Eat It is a landmark book, and one that should encourage us all to look more carefully at nutritional chemistry and more broadly and deeply at the human condition.

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THE MAYA MEDICINAL TURTLE, *XKOKAK*, AND A SUGGESTED ALTERNATE READING OF TWO YUCATEC ETHNOMEDICAL TEXTS

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ABSTRACT.—According to Maya informants in northern Belize, the plastron of a type of turtle called ***xkokak*** is used in the treatment of respiratory ailments. This use is recorded in northern Yucatan as well. This turtle's salient characteristic is a hinged, moveable plastron that can close up the shell; the folk taxon may include both mud turtles *(Kinosternon* spp.) and the box turtle *(Terrapene carolina).* Based on the ethnographic evidence, it is suggested that the ***kokak*** mentioned in two published Colonial Period medical texts with the translation "asthma grass" may be plausibly reinterpreted as a reference to this turtle.

RESUMEN.—Según informantes mayas en el norte de Belice, el peto de un tipo de tortuga llamada ***xkokak*** se usa en el tratamiento de enfermedades respiratorias. Tal uso está documentado también en el norte de Yucatán. La característica sobresaliente de esta tortuga es el peto movible, a manera de bisagra, que puede cerrar el caparazón; es posible que el taxón maya ***xkokak*** incluya tanto a las especies de *Kinosternon* como a la *Terrapene carolina.* En base a la evidencia etnográfica, sugiero que el ***kokak*** mencionado en dos textos médicos de la época colonial, y traducido como "hierba del asma," es plausible reinterpretarlo como una referencia a esta tortuga.

RÉSUMÉ.—Selon des informants Mayas au nord du Bélize, le plastron d'une sorte de tortue appelée ***xkokak*** est utilisé dans le traitement des maladies respiratoires. Cet usage se retrouve aussi au nord du Yucatan. La caractéristique très particulière de cette tortue est un plastron mobile à charnière qui peut refermer la carapace; la catégorie taxonomique ***xkokak*** inclut peut-être les espèces de *Kinosternon* et la *Terrapene carolina.* A la base des preuves éthnographiques, je propose que le ***kokak*** mentionné et traduit comme "herbe d'asthme" dans deux textes médicaux de l'époque coloniale puisse être réinterprété comme une référence à cette tortue.

INTRODUCTION

As an adjunct to a zooarchaeological study in Corozal District, northern Belize, I conducted interviews with Maya archaeological workers from the villages of Chunox and Copper Bank concerning the animals available in the area and their utilization. Among the animals discussed were several that have medicinal uses. One of these, described by two informants, is a turtle called ***xkokak***.[1] The ***xkokak*** is described as having a closable plastron and three ridges on the carapace. It inhabits cool, moist forest areas but can also be found in seasonal ponds, or *aguadas,* and near settlements.

IDENTIFICATION AND USES OF THE *XKOKAK* IN NORTHERN BELIZE

Xkokak specimens were not observed in the course of my fieldwork; identification of this turtle in terms of scientific taxonomy had to be based on the brief description provided in the interviews. Its most distinctive characteristic is the closable shell. Two types of turtles in the Maya lowlands exhibit this characteristic: the mud turtles *(Kinosternon* spp.) and the box turtle *(Terrapene carolina yucatana* Boulenger).

The distribution of the box turtle, according to Lee (1977:34, 163), is far to the north of Belize, mainly in the Mexican state of Yucatan. Neill (1965:125) lists it as a questionable record in Belize.

Mud turtles definitely occur in Belize, and one form, *Kinosternon scorpioides* L. (cited in some sources as *K. cruentatum),* has three ridges on its shell (Iverson 1976:260; Neill 1965:119). On this basis, I have tentatively identified the ***xkokak*** as *K. scorpioides.* Complicating this identification, however, is the fact that the Maya recognize another small three–ridged turtle called ***xtuk'is,*** which is known for its foul odor. This has also been identified as a mud turtle, since the related musk turtles or stinkpots are not recorded in the region. In the folk zoological system a clear distinction is made between the two turtles, only one of which is utilized. Their exact equivalents in the western taxonomic system have yet to be clarified. All mud turtles can produce an unpleasant odor, but their propensity to do so may vary individually. It is possible that the Maya classification makes a finer distinction within a single scientifically recognized species.

The ***xkokak*** is used as a source of medicine to combat colds and asthma in babies. The chest area of the plastron is scraped to form a powder, which is mixed with water and given to the sick baby to drink. In contrast to most turtles, the meat is not eaten, except occasionally by elderly people. Even then the meat is more than an ordinary food, serving as a tonic to improve health.

THE *XKOKAK* IN THE YUCATAN

The taxonomic term ***kokak*** is also recorded in the Yucatan. It is listed in the *Diccionario Maya Cordemex* (Barrera Vásquez et al. 1980:330) and tentatively identified as the box turtle, *Terrapene.* This identification is likely to be correct in the Yucatan, which is within the known range of this turtle (Lee 1977:163). Nevertheless, a mud turtle observed at Chichén Itzá, Yucatan, in 1986 was identified by local Maya archaeological workers as a ***xkokak.*** It may well be that the term covers both turtles where their ranges overlap. Although differing in other ways, the two are united by their possession of a closable plastron. I believe that this is the key criterion by which the taxon is defined.

The Cordemex dictionary (Barrera Vásquez et al. 1980:330) mentions the medicinal use of the ***kokak*** as well. It states that this turtle is used to cure asthma and persistent coughs. Details of the treatment are not provided.

Similar medicinal uses, then, are associated with this turtle over a wide area. There are exceptions, however. The informants who identified the ***xkokak*** at

Chichén Itzá, when questioned about medicinal uses, denied that the turtle had such a function. Nor is a turtle mentioned in the asthma treatment recorded by Redfield and Redfield (1940:67) in Dzitás, Yucatan.

Some other statements in the Yucatec ethnographic literature may refer to this turtle. Redfield and Villa Rojas (1962:177) mention that an amulet made from a "tortoise" plastron is used in Chan Kom, Yucatan, to guard against respiratory ailments in children. The plastron can also be boiled and the water drunk as a treatment. Although the preparation is different, the anatomical part used and the illness for which it is the chosen treatment are the same as in Belize. The plastron itself is called ***kokak*** by Redfield and Villa Rojas. The tortoise is said to be considered sacred for reasons beyond its effectiveness against asthma: during droughts, it is seen walking along with tears of sympathy in its eyes for the drought-stricken farmers; its tears help to draw the needed rain. Moreover, it carries the sign of the cross on its plastron (Redfield and Villa Rojas 1962:177, 207).

THE MEANING OF THE TERM *KOKAK* AND ITS ASSOCIATION WITH ASTHMA

Kokak is a compound term consisting of the elements ***kok*** and ***ak,*** the latter meaning "turtle."

Barrera Vásquez et al. (1980:329) provide several definitions of ***kok,*** three of which appear relevant here: "asthma," "dry or rotten gourd," and "terrestrial turtle." That the third definition is not simply an abbreviated version of ***kokak*** is suggested by the fact that the word ***kok*** for "turtle" is used mainly in Guatemala, whereas ***ak*** is more common in Yucatan (Seler 1923:654).[2] The term ***kokak,*** then, could literally mean "turtle turtle." An alternative meaning, "asthma turtle," is indicated by one of the definitions presented by Barrera Vásquez et al. (1980:330): "*tortuguita del asma.*" A third possible meaning is "dry gourd turtle," as implied by Roys (1931:329). According to this interpretation, the term was probably based on the similarity of the ovoid closed-up shell to a gourd.[3]

The frequency of homonyms in the Yucatec Maya language, which complicates efforts to understand the etymology of specific terms (cf., Roys 1965:xxv), also provides a variety of pathways by which a particular animal or plant could have come to be associated with a particular disease. If the original meaning of the term ***kokak*** was something other than "asthma turtle," the medicinal use could have followed as a consequence of the homonym ***kok.*** Homonyms are known to play a role in traditional Maya symbolism (Roys 1965:xix-xx).[4]

If, on the other hand, "asthma turtle" is the original meaning of the term, we are left with the question of how the animal became associated with the disease in the first place. Such associations sometimes arise from physical similarities between the symptoms of a disease and the curative item—for instance, "blood-vomit" is treated with red feathers (Roys 1931:63). Perhaps in the case of ***kokak*** an analogy was seen between the closure of the turtle's shell and the blockage of breathing in an asthma attack. Box turtles can close up so tightly that "a person who did not know that a reptile in a state of repose uses very little oxygen might wonder why a tightly closed box turtle would not soon suffocate" (Pope 1955:68).

Another line of reasoning, more applicable to the mud turtle than to the terrestrial box turtle, involves the former's amphibious nature. That the Maya may have likened asthma to a sensation of drowning is suggested by frequent references to water in incantations to cure this disease (Roys 1965:xviii). Amphibious turtles in general can give the impression of being immune to this problem. Further ethnozoological inquiry may ultimately clarify the origin of the ***kokak***'s name and the reason for its connection with asthma, questions that are of interest with regard to general patterns of nomenclature as well as Maya medical epistemology.

AN ALTERNATIVE INTERPRETATION OF TWO YUCATEC MEDICAL TEXTS: "ASTHMA GRASS" OR "ASTHMA TURTLE"?

In his monumental work *The Ethno-botany of the Maya,* Ralph Roys (1931:9–10) presents two Colonial Period medical prescriptions for treating respiratory ailments with a material called ***kokak.*** This is translated as "asthma grass" and tentatively identified as a type of moss (Roys 1931:225). Although Roys points out in both his plant and animal lists that the term also refers to a certain small turtle, he clearly believes that it is the plant that is referred to in the medical texts (Roys 1931:225, 329). The words for "grass" and "turtle" ***(ak)*** are homonyms in Yucatec Maya.

Although it is true that more plants than animals are used medicinally, I propose on the basis of the ethnographic evidence presented here that "asthma (or gourd) turtle" is a plausible alternative translation for the ***kokak*** mentioned in these texts. Indeed, this interpretation renders the otherwise puzzling wording of the prescriptions more understandable. Key phrases are the following (spelling as in original):

Cha cocaac, hunxeth u boxel ... ca a huch tulacal catun a ɔa yuke ...
Take the coc–ac, a piece of the husk or outside ... Mash them all and give it to drink ... (text no. 18, p. 9)

... tocbil u boxel cocac, hunppel cuchara u may bin ɔabac ichil uabal uklil ...
... burn the exterior of the coc–ac (asthma–grass). One spoonful of the fine ashes is to be put into whatever the patient drinks. (text no. 19, pp. 9–10)

The word ***boxel,*** translated as "husk" or "exterior," also refers to the shell of a turtle (Barrera Vásquez et al. 1980:66). Whereas it is difficult to picture what is meant by the "husk" of a moss, except on an almost microscopic level, the word makes perfect sense if the text refers to a turtle. Substituting this interpretation, these Colonial Period medical prescriptions fall in line with the treatments recorded more recently in both the Yucatan and Belize.[5]

CONCLUSIONS

Ethnographic evidence in the Maya lowlands points to the widespread recognition of a taxon ***xkokak*** which may encompass both mud turtles and the

box turtle. These otherwise rather different turtles are united by the characteristic of a hinged plastron which allows the shell to close up. The use of the plastron to treat respiratory problems may be either a cause or a consequence (through homonymy) of the name applied to this turtle. Such a use occurs in various parts of the Yucatan Peninsula at present. I suggest that it was recorded in Colonial times as well.

NOTES

[1]I have followed the spelling of the *Diccionario Maya Cordemex* (Barrera Vásquez et al. 1980), a slightly modified version of the traditional Spanish-based orthography of Yucatec Maya. The ***k*** as used here is equivalent to ***c*** in most earlier publications. The ***x*** is an optional prefix; I use ***xkokak*** or ***kokak*** following the source cited or informant usage.

[2]***Kok*** as a term for "turtle" occurs in dialects of Tzeltal, Tzotzil, Chol, Ixil, Kekchi, Cakchiquel, Quiche, Pocomchi, and Pocomam in addition to Yucatec, and there is phonological evidence that the term is widely diffused (Cecil H. Brown, personal communication 1991). Brown suggests that the term could, in fact, have arisen from "asthma turtle" in Yucatec and diffused in a truncated form.

[3]Since ***kok*** alone can mean "turtle," it can also be argued that the semantic extension worked the other way around, from the turtle to the similarly hard-shelled gourd.

[4]Indeed, Kelley (1976:122) provides an example involving the word ***kok***. Yet another meaning of ***kok*** is "miserable" or "scarce;" Kelley argues that this concept is symbolized by turtles pictured in the Maya codices.

[5]Further doubt is cast on the "asthma grass" interpretation by the fact that two major later ethnobotanical works have not recorded a plant by this name (Barrera Marín et al. 1976; Mendieta and del Amo 1981).

ACKNOWLEDGEMENTS

My ethnozoological interviews and observation of a ***xkokak*** turtle were made possible by my participation in the archaeological projects at Cerros, Belize (directed by David Freidel) and Chichén Itzá, Yucatan (directed by Charles Lincoln). I would like to thank Victoria R. Bricker and Munro S. Edmonson of Tulane University for their comments on a draft of this article. I also thank the Belizean and Yucatecan informants who shared their knowledge with me.

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BOOK REVIEW

Phytoarchaeology. Robert R. Brooks and Dieter Johannes. Portland, Oregon: Dioscorides Press, 1990. Pp. 268. 20 color and 32 b/w photos. $39.95. ISBN 0–931146–16–X.

The two authors of this book—both outstanding specialists in archaeoethnobotany—approached phytoarchaeology from different fields of research. The first, a New Zealander, is an expert who was intrigued with results from studying two different sites thousands of miles apart, in Corsica and in Zaire. The second conducted research based on vegetational studies in mineralized areas in Germany. ''It was,'' as the authors confess in their preface, ''a difficult book to write because of the wide range of disciplines covered and the wide dissemination of the literature in several languages.'' They have, this confession notwithstanding, done a magnificent piece of writing and have produced a volume which will long stand as an example of superb research.

The volume is arranged under two parts: Part I, General Principles, with nine chapters; and Part II, Aerial Phytoarchaeology, with seven chapters. The extraordinary coverage—technological and geographical—are evident in these parts. There follows a glossary of terms, a botanical index, a geographical index, and a subject index.

The book is superbly produced by Dioscorides Press which must be congratulated for publishing a jewel at such a reasonable price. The authors are to be thanked for their multidiscipliannry treatment, much to be desired in this period of extreme compartmentalization.

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SOME OBSERVATIONS ON THE NATURE OF PAPYRUS BONDING

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ABSTRACT.—Papyrus (*Cyperus papyrus,* Cyperaceae) was a multi-use plant in ancient Egypt. Its main use, however, was for the production of laminated leaves which served as writing material in the Mediterranean world for almost 5000 years. Being a royal monopoly, the manufacturing process was kept secret. Plinius Secundus, who first described this process, is unclear as to the adhesive forces bonding the individual papyrus strips together. Various authors of the past century advanced their own interpretation on bonding. The present authors believe that the natural juices of the papyrus strip are sufficient to bond the individual strips into a sheet, and that any additional paste used was for the sole purpose of pasting the individual dried papyrus sheets into a scroll.

RESUMEN.—El papiro (*Cyperus papyrus,* Cyperaceae) fue una planta de uso múltiple en el antiguo Egipto. Su uso principal era la producción de hojas laminadas que sirvieron como material de escritura en el mundo meditarráneo durante casi 5000 años. Siendo un monopolio real, el proceso de manufactura se mantenía en secreto. Plinius Secundus, quien describió este proceso por primera vez, no deja claro qué fuerzas adhesivas mantenían unidas las tiras individuales de papiro. Diversos autores del siglo pasado propusieron sus propias interpretaciones respecto a la adhesión. Consideramos que los jugos naturales de las tiras de papiro son suficientes para adherir las tiras individuales y formar una hoja, y que cualquier pegamento adicional se usó unicamente para unir las hojas secas individuales para formar un rollo.

RÉSUMÉ.—En Egypte ancienne, le papyrus (*Cyperus papyrus,* Cyperaceae) était une plante à utilisations multiples. Cependant, son utilisation principale était la production du papier laminé utilisé pour la rédaction de documents dans le bassin Mediterranéen pendant près de 5000 ans. En tant que monopole royal, le procédé de fabrication était resté secret. Plinius Secundus, qui a été le premier à décrire ce procédé, demeurait imprécis quant aux forces d'adhésion maintenant les fibres du papyrus ensemble. Différents auteurs du siécle passé ont avancé leur propres interprètations de ces liaisons. Les auteurs du présent article pensent que les jus naturels des tiges de papyrus suffisent pour lier les bandes individuelles en une feuille et que toute colle utilisée en plus avait pour seule fin de coller les feuilles de papyrus entre elles en un rouleau de papier laminé.

INTRODUCTION

Laminated papyrus was the writing material of the Mediterranean world for over 5000 years. The oldest papyrus in existence is an uninscribed roll from the tomb of Hemaka at Saqqarah, in the first dynasty, and is about 5200 years old. Papyrus was the vehicle through which knowledge passed from one generation to the next. It was partially replaced by parchment and vellum and later by linen pulp paper, which was invented by the Chinese some time before A.D. 105. The Arabs learned this true paper-making process from prisoners at the siege of then Chinese Samarkand in A.D. 751. Baghdad soon saw the establishment of the first Arabian pulp paper factory in A.D. 795. Being easier and more economical to make, such pulp paper-making resulted in the abandonment of both papyrus-making and the cultivation of papyrus on plantations. Thus, in the second half of the tenth century, the famous Egyptian papyrus protopaper manufacture died out, as did soon afterwards that near Palermo, where papyrus probably was introduced by Arab merchants before A.D. 972. Today there are small industries at Syracuse in Sicily, and at Giza, Cairo, producing primarily papyrus souveniers for the tourist trade.

Papyrus, *Cyperus papyrus* L. (Fig. 1), was a multi-use plant. The flowering heads were used as garlands; the roots as food, fuel, and for making utensils. The culms, or stalks, were used in early architecture, for shelter, boats, sails, mats, baskets, cloth, sandals, cordage, as well as for food, incense, medicinal ash, and for many other uses (Täckholm 1941:102–133). Above all, papyrus was used for the production of laminated protopaper (Fig. 2) used primarily for scrolls.

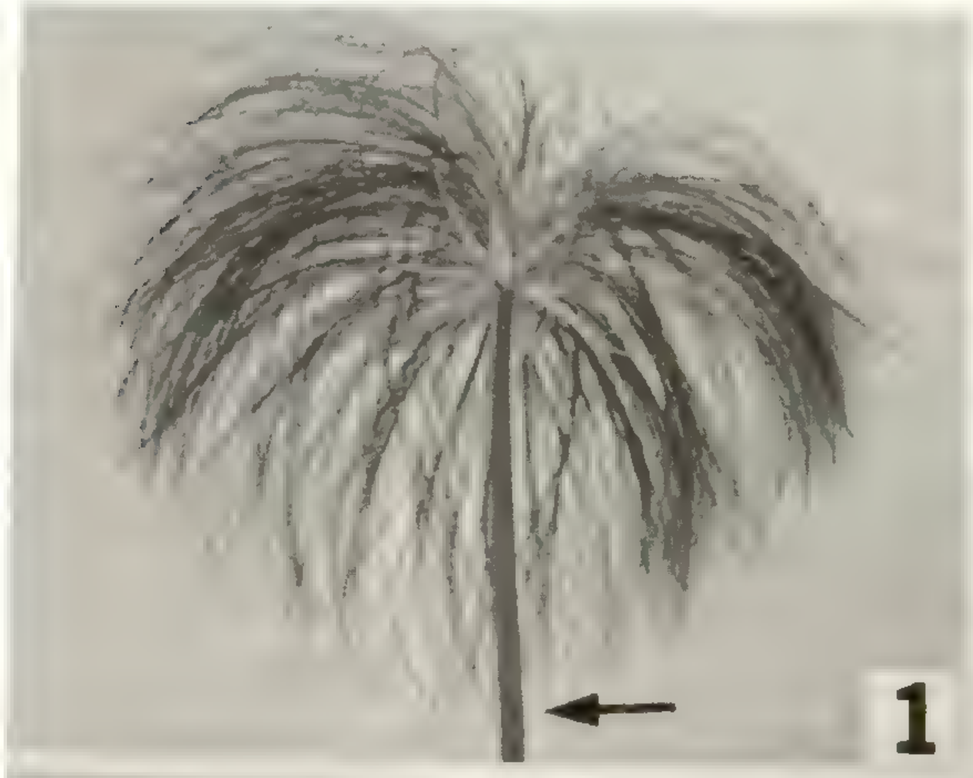
Papyrus scrolls served as currency in Egypt's foreign trade and topped the export lists along with linen textiles. The royal house proclaimed papyrus manufacture and trade a state monopoly, allowing no private production of it. Thus, no records of papyrus sheet-making were depicted in tombs or temple paintings, cut into stone, or written on papyrus itself.

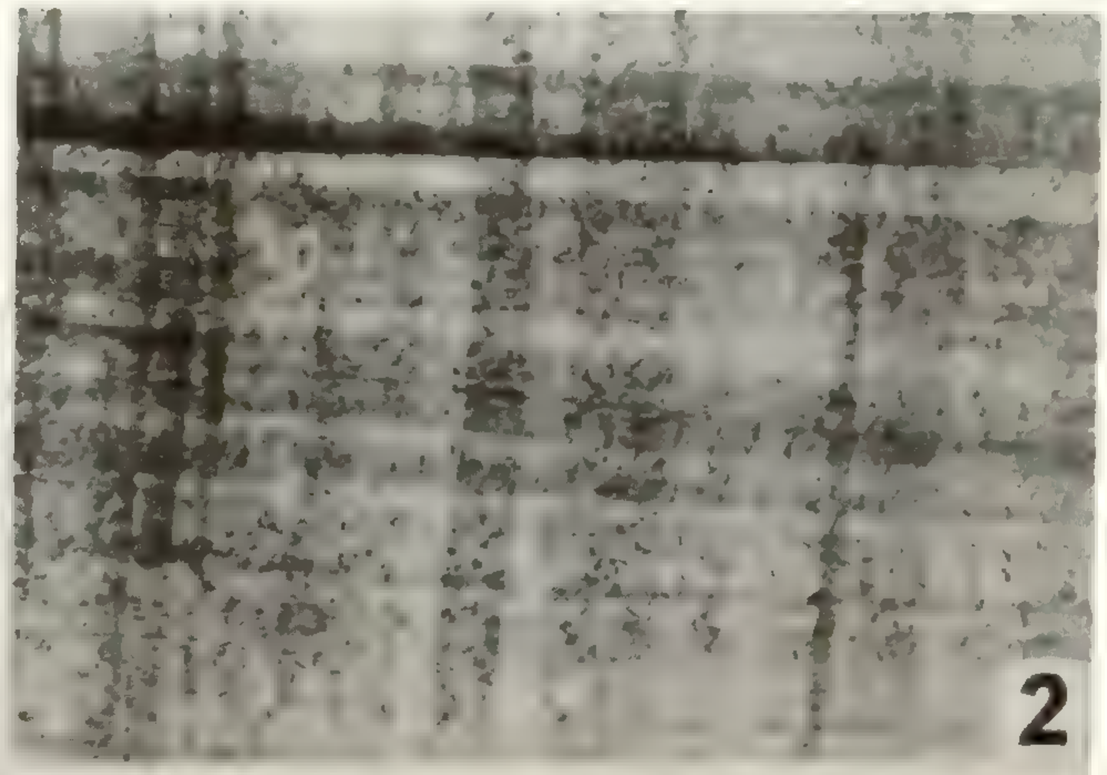
The papyrus plant is a perennial reed which grows in lakes and pools in shallow, stagnant water. From its pith *(bublio),* leaves *(scrools)* or books *(biblos, biblion)* were made which, by 670 B.C., were traded to the Greek world through the Phoenician port of Gubal. The Greek word for papyrus reed *(bublos)* is reflected in Byblos, the Greek name for this port. The origin of the term *papuros,* attested in Greek since Theophrastus, is thought to be of Egyptian origin, meaning "that of the king." The words *paper, papir, Papier, papel,* and *papiro* are all derived from it.

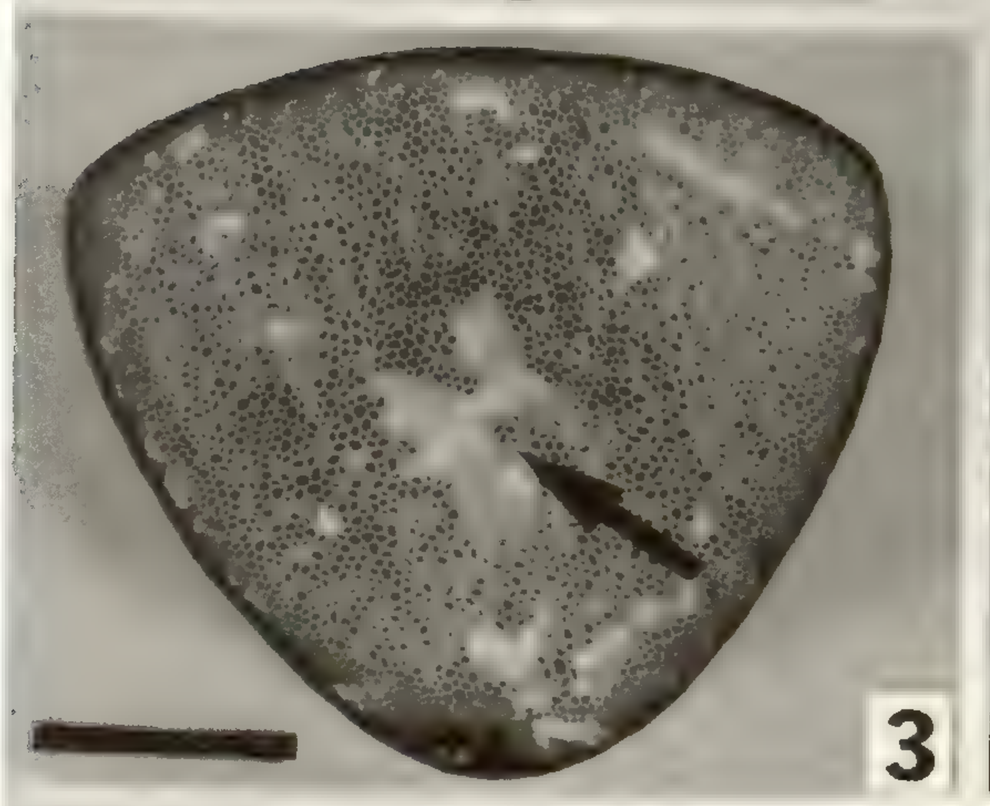
PAPYRUS MANUFACTURE

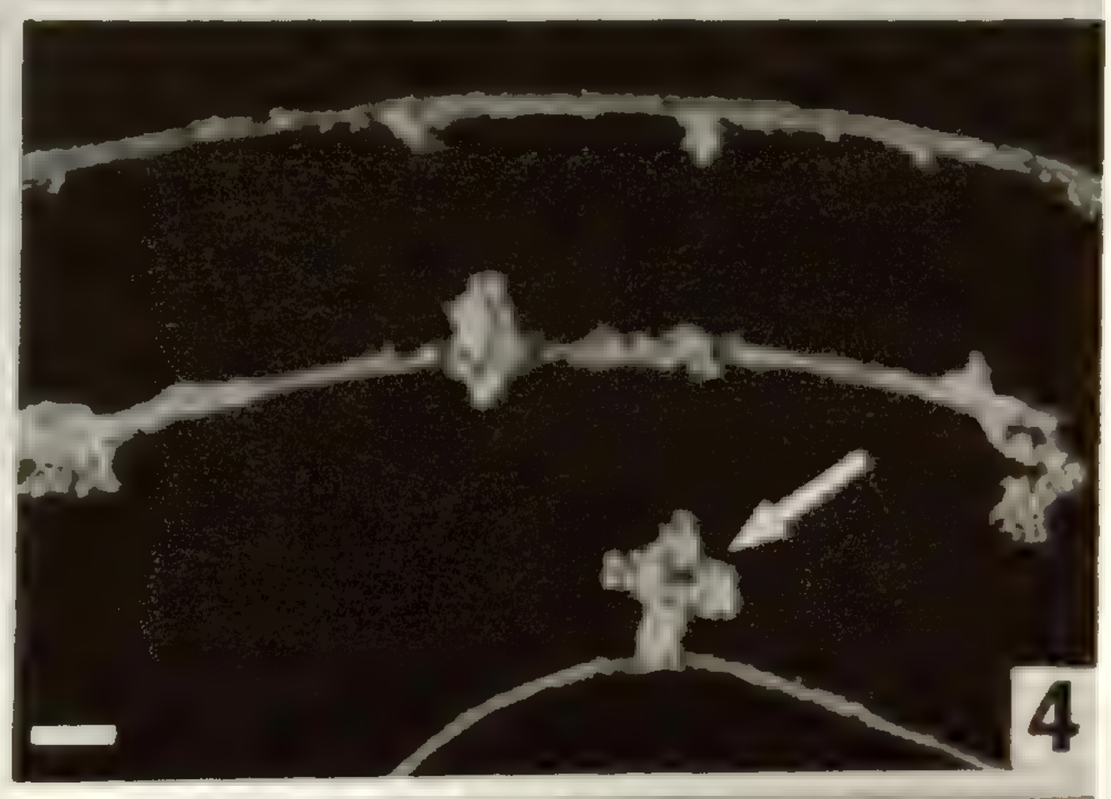
The classical reference on ancient papyrus manufacture is Pliny's (A.D. 22–79) *Natural History XIII,* 74–82. He probably never saw papyrus sheet production himself, but must have had it explained to him. After explaining different grades of papyrus, he writes: "texitur omnis madente tabula Nili aqua. turbidus liquor vim glutinis praebet" (Plinus XIII, 77, 1967:443) (Every [type of paper] is fabricated on a board moistened with water from the Nile; the muddy liquid supplying the strength of glue) (retranslated by the authors).

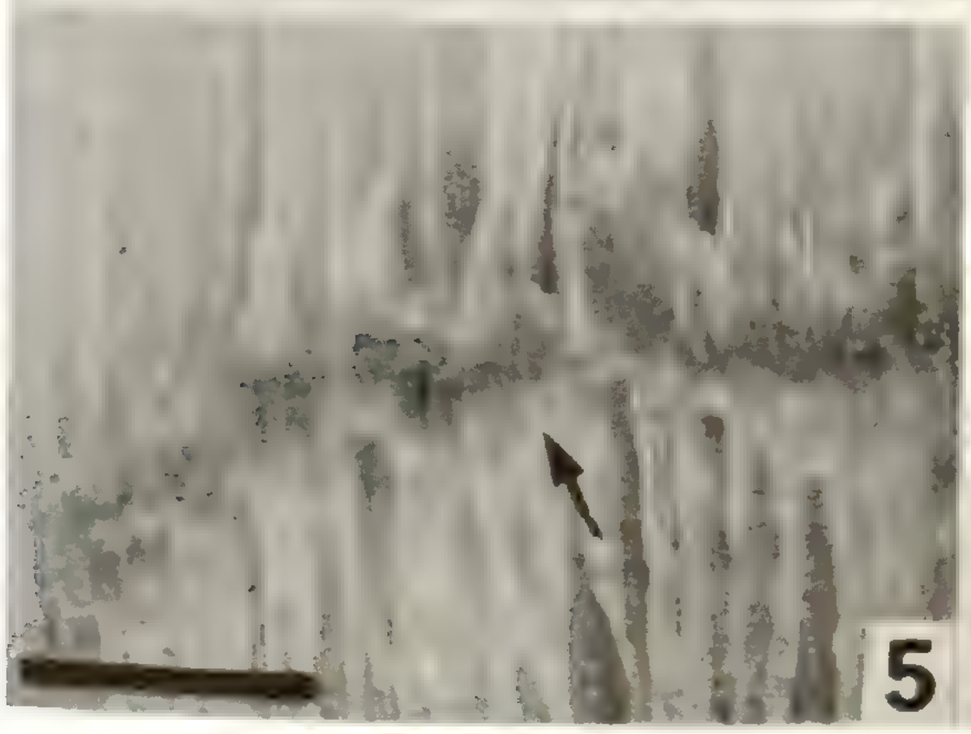
Basically, a papyrus sheet is made by carefully cutting a papyrus culm into pieces of desired sheet length (in ancient times, about 40 cm), peeling the rind off these, and slicing the pith into thin layers from the narrowest of the three angles of the triangular stem to the middle of the opposite side. Further cuts are











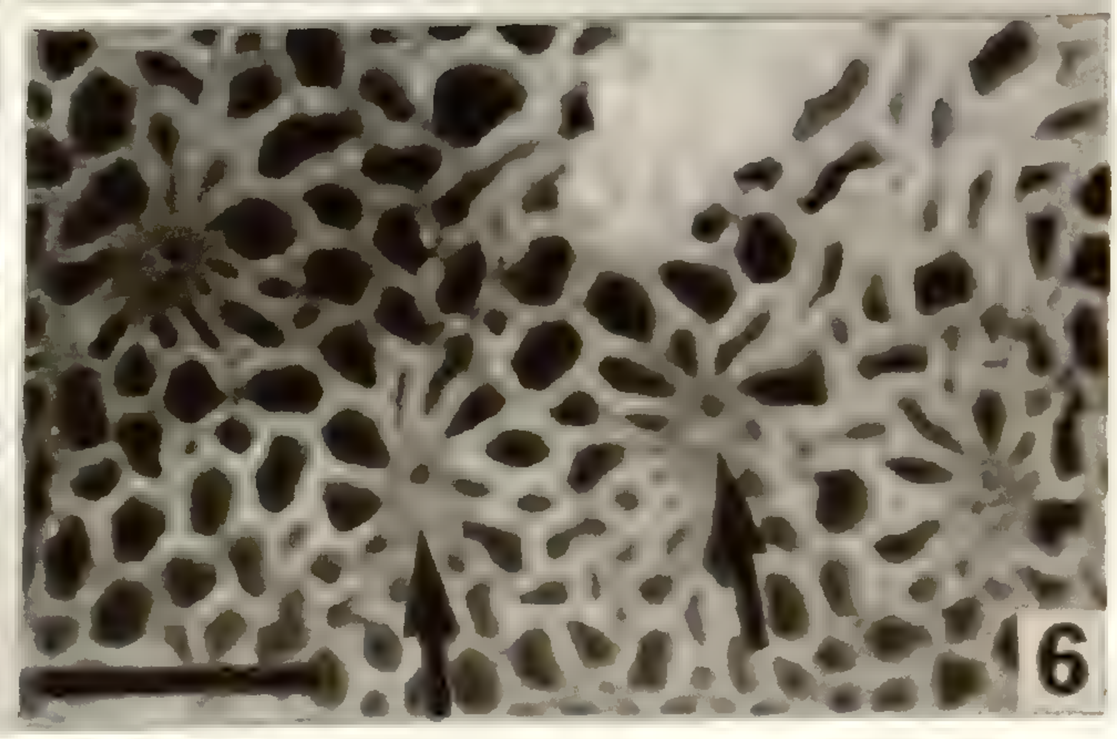


FIG. 1–6. (1)—*Cyperus papyrus* floral head and culm (arrow). 1/10 natural size. (2)—Laminated papyrus paper sheet with small specs. 1/2 natural size. (3)—Cross section of papyrus culm with polysaccharide exudates (arrow). Bar equals 0.5 cm. (4)—Fibrovascular bundles with polysaccharide exudate (arrow) after cellulase–pectinase digestion. Bar equals 2 mm. (5)—Phloem bundle exudate (arrow) traversing longitudinally cut culm cells. Bar equals 1 mm. (6)—Cross section of papyrus culm showing distances between fibrovascular bundles (arrow). Bar equals 1 mm.

then made parallel to this longest cut. These strips are leached in water until translucent, and pounded. Then, while still moist, they are laid horizontally on a board, one above the other overlapping by 1–2 mm. A second layer is then laid at right angles vertically covering the first layer, and both are pounded and subsequently pressed together until dry. Hendriks (1980), as well as Wallert (1989), propose that next to this strip method, papyrus may also have been made by the peeling method.

After drying, the edges of the sheets are cut straight and used individually or assembled to form a scroll, which often contained 20 or more sheets. Sheets are assembled all with the horizontal layers on one side and the vertical layers on the other, overlapping the right-hand sheet by about 1 cm. The overlap is pasted together with paste made from fine wheat flour and then pounded together. It is said that the invention of papyrus was important for the development of hieratic writing, which was written from right to left (Möller 1909:4). The individual characters, however, were written from left to right. Since a smooth flow of the writing brush was important, the overlap of the papyrus sheet had to be from the left to the right. The brushes were made from halfagrass, rushes, and split palm leaves. Later, a reed was cut and used as a pen. In antiquity, scrolls were prepared in factories. Individual scribes cut or augmented such standard scrolls themselves as needed by adding individual sheets or parts of another scroll. In some instances, the backside, or *verso,* was used to finish a story.

In order to protect the writing, a scroll was rolled with the horizontal fibers on the inside. In later times, scrolls were rolled around a shaft of wood, and both edges were reinforced with an additional vertical papyrus strip as protection from fraying. Papyrus was not folded; its resistance to folding was minimal. There were many qualities of papyrus used in ancient times. Pliny enumerates them in detail, and Dziatzko (1900:49–103) gives a good account of their various sizes.

THEORIES ON THE NATURE OF BONDING

Ever since interest in papyrus-making was kindled in the last few centuries, one point of the papyrus production procedure remained a mystery far into the second half of our century—namely, whether the horizontal and vertical layers of which a papyrus sheet consisted were pasted together with any type of adhesive. We shall consider a few opinions on this matter.

As Lewis (1974:22) points out, according to Theophrastus's *Historia Plantarum,* people chewed the papyrus stalk, raw, boiled, or baked … and it was one of the three sweetest aquatic plants growing in Egypt. Bruce (1805:20), who described his paper-making attempts in Abyssinia and Egypt, added that it appeared to him "that the sugar or sweetness, with which the whole juice of this plant is impregnated, is the matter that causes the adhesion of these strips together." Both authorities implied that sugar was present.

From sugar to starch was only a small step. Thus, Täckholm (1941:102–133) reported that the papyrus rhizomes were starchy, and Lewis (1974:22) in a reprint of his doctoral dissertation of 1934 states that "next to providing the raw material for the paper of antiquity, the commonest use of the papyrus plant was as a

foodstuff. The plant is, in fact, a fairly good source of starch.'' The *Introductory guide to the Egyptian collection* (British Museum 1964:81) suggested that the natural starch in the juice of the plant itself acted as adhesive. As late as the 1970s, Dimbleby (1978:48) wrote that for the manufacture of large papyrus sheets, wheat starch was added as an adhesive. However, Möller (1909:4), describing the pressing and pounding of the vertical and horizontal layers together, added: ''Wobei eine ganz dünnflüssige Gummilösung als Bindemittel diente'' (whereby a very thin rubber solution served as binding agent), and von Wiesner (1928:676) stated that for adhesion, ''ein Kleister benutzt (wurde) der aus unreiner Staerke, vielleicht aus Mehl, bereited wurde'' (an adhesive was used which was made out of impure starch, perhaps of flour)(translations by the authors).

Cerny (1952:3–36) noted that the fibers of ancient papyrus were joined together by an adhesive soluble in water, probably gum arabic or egg white. And Forbes (1954:244) wrote that ''the gum produced by *Acacia nilotica* was used in making papyrus.''

The *Encyclopedia Judaica* (1971:71) noted that paper was made from the stalk '' ... which was cut into fine strips and stuck together in length and in breadth with glue—the *kolon shel soferim* (''scribes glue'') ... '' Other advocates of imagined paste, as well as those who believed it was not necessary, are listed in Lewis (1974:21–69).

CHEMICAL INVESTIGATIONS

The present authors, however, did not detect any sweetness in taste tests. Nor did they detect any starch in tissues of the rhizomes or in those of the culms, which they tested at different growing stages with I_2KI, potassium triiodide. Neither starch nor pectic substances had been detected by Buchala and Meier (1972), who investigated the inner white tissue of papyrus culms, finding fructose, glucose, sucrose, and other oligosaccharides, and traces of polysaccharides in aqueous and 2% ammonium oxalate extracts of the plant material. Reynolds (1967) did not detect any starch, and postulated that galactans and arabans which he isolated in the stem sap served to glue the papyrus strips together, aided to some degree by other carbohydrates and by nitrogenous and phenolic polymers. Both of the latter authors analyzed greenhouse–grown plants.

Votocek (1937), working on dried papyrus strips, had already isolated water–soluble glucose and fructose. By hydrolysis of hemicellulose, he obtained xylosans and glucosans and by hydrolysis of cellulose he obtained d–glucose.

Muthuri and Kinyamario (1989) found 10.9% of crude protein in juvenile umbels and 3.9% in juvenile culms. This percentage dropped to 4.2% and 1.9% in dead tissue, respectively. Thus, the nutritive value of papyrus for grazing potential was similar to East African range grasses. McGovern (1982) found that 13% of the parenchyma pith tissue had lignified in mature papyrus culms, and de Seabra (1955) reported that cortical papyrus culms contained 49% of total cellulose.

Our investigation did not detect any starch nor did that of Buchala and Meier (1972). This is in direct contrast to the reports of Täckholm (1941:102–133) and Lewis (1974:21–69) that starch was present in papyrus. Our inability to detect any

sweetness in papyrus is also in contrast to the report of Theophrastus and to that of Bruce (1805).

We believe that sugars may be present as fructans, long chains of fructose molecules, common in grasses. Laboratory hydrolysis releases the fructose molecules which are very sweet and also the sucrose present at the ends of the long chains. This would account for the finding of these molecules by Buchala and Meier (1972). Boiling and baking would also hydrolize the fructans and explain the statement by Theophrastus. Bruce's remark (1805) we can only try to explain by the fact that at the end of harvest time, the fructans are converted into sucrose to be translocated to the rhizomes for storage and the possiblity that Bruce harvested and tested the papyrus just as the right time of translocation. Another possibility may include mutation of papyrus.

MODERN PAPYRUS MANUFACTURE

The art of papyrus–making has been resurrected in modern times. At Anapo, Syracus, Sicily, fabrication according to Pliny's description began towards the end of the eighteenth century by F.S. Landolina with local plant material from the river Ciane (Ragab 1980:94). Bruce (1805), in the late eighteenth century, made several pieces of papyrus both in Abyssinia and in Egypt. He described it as always thick and heavy, drying very soon, then turning firm and rigid, and never white. In Berlin, Ibscher produced satisfactory white papyrus leaves early in 1913 from plants grown at the Berlin Botanical Garden (Deissmann 1923:21–22). Gunn made good papyrus in Cairo from plants grown in his own garden at El Ma'adi (Lucas and Harris 1962:138). It was nearly white but, according to him, unfortunately marred by numerous small light brown specks (Fig. 2), which he thought could have been avoided by special precaution. A similar account was iterated by Cerny (1952:3–36). Von Wiesener (1928) thought they represented thin oblique vascular bundle strands connecting the regular vascular bundles. Ragab (1980) called them ''diaphragmes'' and Wallert (1989) ''interconnecting slanting thin fibrous bundles.'' These specks, in the opinion of the present authors, were amorphous polysaccharide exudates (Fig. 3, 4, 5) emanating from the vascular bundles (Fig. 6) into the surrounding parenchyma cells. We digested the cellulose of the middle lamella and the cell walls enclosing the middle lamella with a solution of 0.5% pectinase and 1.5% cellulase (Fig. 4). These exucates are genus specific and can be used to detect adulteration of some of today's papyrus with corn (*Zea mays* L.) or *Cyperus alopecuroides* Rottb., which grows abundantly in Egyptian waterways.

Following Gunn's method, Lucas, who had been previously unsuccessful making papyrus using dried stem material from the Sudan, succeeded in producing papyrus similar to Gunn's (Lucas and Harris 1962:137–140). More recently, satisfactory papyrus has been produced by Baker of the British Museum (Lucas and Harris 1962:137–140) and also by Hepper of the Royal Botanic Gardens at Kew (Reynolds 1967). In 1968, Dr. Hassan Ragab opened the Papyrus Institute in Giza and reintroduced papyrus–making as a cottage industry in that region.

He described the bonding of his modern papyrus as the hooking together of fibers during pressing and forming to hold the strips together (Ragab 1972). Later, he proposed that the cells of the strips formed dove-tail joints under pressing (Ragab 1978). Thus, the adherence was perceived to be more physical than chemical, with the vascular bundles strengthening the cross-laminated sheet in both directions. Later, however, he understood augmented adhesion to be due to increased pressure, which causes the squashed parenchyma cells to fill the open spaces of the interstices to form a very smooth structure (Ragab 1980).

McGovern (1982), interested in bonding mechanisms of various pith-containing plants, found that the parenchyma network was compacted in papyrus and corn mats which he produced by ambient press drying.

The present authors produced many cross-laminated papyrus sheets from fresh garden material harvested in 1988. We made papyrus sheets using their natural juices only. Many were excellent. Sheets made from dried papyrus slices, which prior to use were soaked in water for three days, also gave good adhesion for over three years. We do not recommend polishing the upper surface with stone, shell, wood, ivory, or pumice to remove blemishes, as mentioned by Plinius (XIII, 81), Täckholm (1941):102–133), Cerny (1952:3–36), Lucas and Harris (1962:137–140), and Bell (1985:146). Such polishing will disturb the smoothness of the outer pressed parenchyma tissue and may result in feathering of the ink. Any hole in a sheet or any thin area is easily patched by adding a fresh strip of the required length over the defective place and thoroughly pounding it until it merges into the rest of the sheet. Then the sheet should be pressed between felts until dry. Several changes of felts are necessary during the press-drying period.

We also tried various additives as mentioned by previous authors. We brushed a wheat flour slurry or egg white between the papyrus layers. These sheets later became stiff and hardly flexible, however. Additional sheets made from macerated and pressed pith tissue were coarse and not at all suitable for writing upon. Other sheets made from macerated pulp into which wheat flour (5%) or egg white (3%) had been added were strong and smooth to write on (Figs. 7, 8), but extremely stiff. To investigate the theory of interfelting, we pressed sheets from macerated pulp from which all protoplasmic cell parts had been flushed away, so that only the fibrous material was left (Fig. 9). These sheets held together firmly, but were not at all suitable for writing because of the coarseness of the fibrous material.

In our culm material, we observed the spacing of the monocot xylem and phloem bundles to average 1.2 mm apart (range 0.6–2.0 mm) (Fig. 6). Pith slices cut lengthwise from the lowest 30 cm of culm above water level averaged 2 mm in thickness. Pressing these pith slices together compressed the density of the fibrovascular bundles in a papyrus sheet more than six-fold after drying. As structural reinforcement, these bundles provide tensile strength in both directions of the laminated papyrus sheet. They also provide a framework around which hemicelluloses, including their exudates and other chemical substances naturally present in the compacted parenchyma, are firmly set and bonded. The lignified fibers (Fig. 9) were nonbonding. No dovetailing of joints was detected. We thus believe that the natural juices of the culms are sufficient to bond the individual

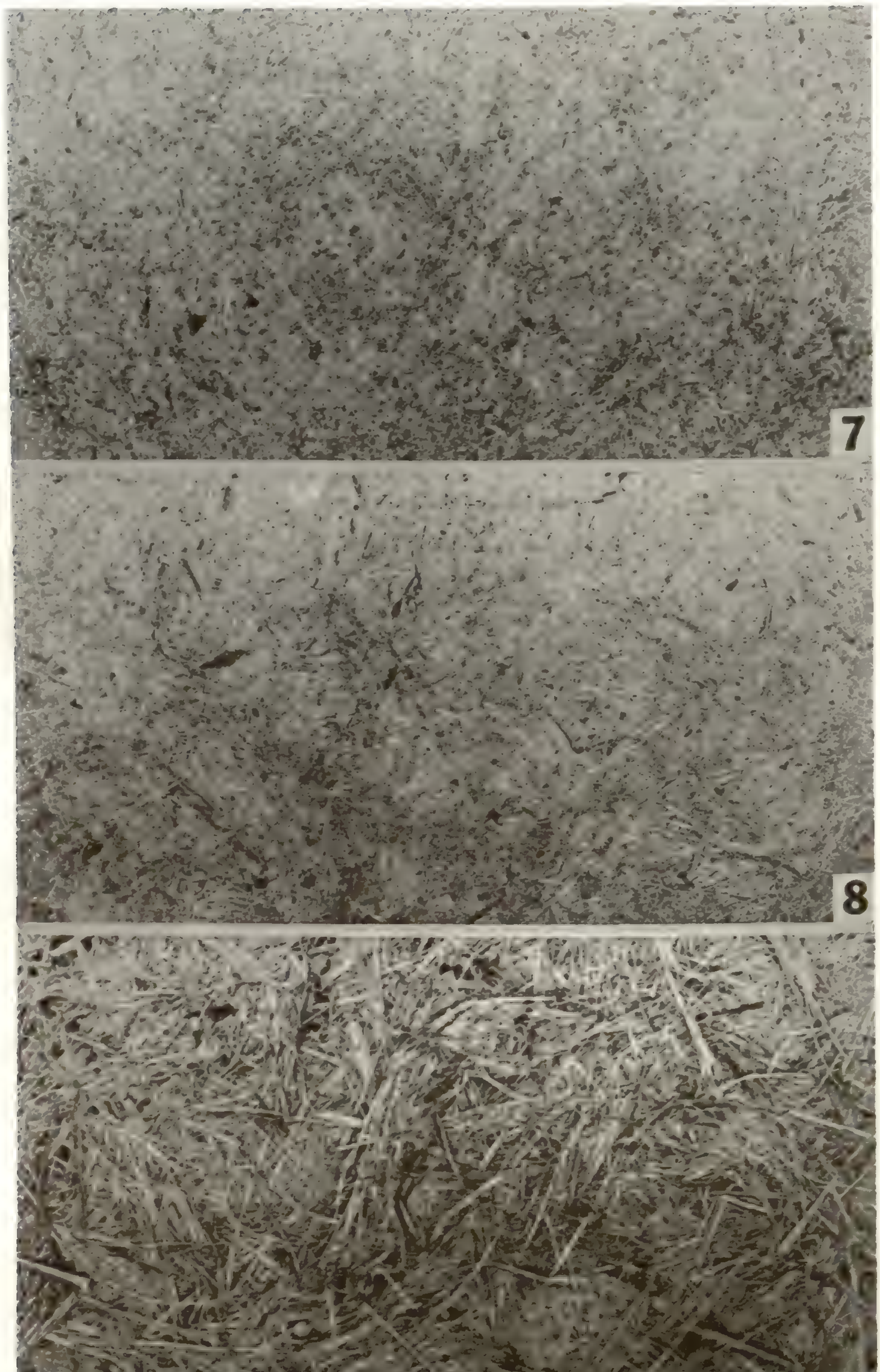


FIG. 7-9. (7)—Macerated papyrus pulp sheet with addition of wheat flour. (8)—Macerated papyrus pulp sheet with addition of egg white. (9)—Macerated papyrus pulp sheet with protoplasmic substances flushed away.

strips together. This suggests that any glue that might have been used such as mentioned in Plinius, referred to the pasting of dried papyrus sheets together to form a scroll, and not to the manufacture of a papyrus sheet *per se*.[1]

We would like to remark on the continuous peeling method suggested by Hendriks (1980) and Wallert (1989). Peeling 10 cm long debarked pieces of fresh papyrus culms with a needle continuously around the core presented no difficulties after initial trials. Peeling 30 cm long culm pieces (about the minimum size of many ancient papyrus sheets) presented various difficulties in peeling. Even large culm sections, with circumferences of about 8 cm, yielded a 9 x 10 x 11 cm wide strip, with one end 9 cm and the other end 11 cm wide. This difference was due to the acropetal tapering nature of the culm.

To produce a 30 x 30 cm large sheet, two layers of 3–4 such wide strips have to be assembled. Each strip has alternating orientation of the basal ends. The discarding of the rest of the culms represents an enormous waste of culm material. The additional time used for peeling versus cutting strips is not regained by speedier assembly. Our trials to continuously peel the culm material at successive stages of desiccation demonstrated that it was increasingly difficult to peel the culm with advanced desiccation. This suggests that after harvest in the swamps, the culms would have had to be speedily debarked, continuously peeled, and flattened.

NOTE

[1]Plinius (XIII, 82, 1967:445): ''glutinum vulgare e pollinis flore temperatur fervente aqua, minimo aceti aspersu, nam fabrile cummisque fragilia sunt. Diligentior cura mollia panis fermentati colat aqua fervente; minimum hoc modo intergerivi, atque etiam lini lenitas superatur omne autem glutinum nec vetustius esse debet uno die nec recentius, postea malleo tenuatur et glutino per curritur, iterumque constricta erugatur atque extenditur malleo.'' [Common paste made from the finest flour is mixed in hot water with a sprinkle of vinegar, for carpenter's glue and gums are brittle. A more careful process percolates hot water through the crumbs of leavened bread; by this method (such) a small amount (of paste) is placed (between the overlap) that even the softness of linen is surpassed. But all the paste used ought to be exactly one day old, not more nor less. Afterwards (the overlap) is flattened with a mallet and run over with paste, and then again has the creases removed and is smoothed out with a mallet.] (retranslated by the authors).

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BOOK REVIEW

Indigenous Peoples and Tropical Forests: Models of Land Use and Management from Latin America. Jason W. Clay. Cambridge, MA: Cultural Survival, Inc., 1988. $8.00 (paperback). ISBN 0–939521–32–6.

Jason Clay, director of research and editor of the quarterly magazine at Cultural Survival, provides us with an overview of management of natural resources by indigenous peoples in Latin America. He organizes this evaluation into five topics—gathering, hunting, fishing, swidden agriculture, and permanent agriculture—drawing examples from various regions of the Neotropics. Towards the end of the book, he integrates these elements in an examination of how indigenous people classify and manage distinct ecological zones, a topic essential to understanding peasant production. He gives a detailed account of three large-scale and putatively sustainable systems of resource management: CRIC Environmental Restoration in Colombia, the Awa Ethnic and Forest Reserve on the Colombia–Ecuador border, and the Kuna Indian forest park in Panama. Clay prefaces these descriptions by stating that " . . . hundreds of similar projects deserve description and analysis."

This statement captures the essence of the book. Rather than a comprehensive review, it is a plan of action for further applied and basic work in the tropics. At the end of each chapter, Clay lists several research priorities; these are reiterated in his conclusion to the book. The ample, 37–page bibliography is by no means exhaustive, an indication of the quickening pace of publications on this critical aspect of the world environmental and ethnic crisis.

Given the brevity of the presentation, some chapters are more satisfying than others. The admirable 20–page chapter on slash–and–burn cultivation combines an excellent overview with examples and case studies from Brazil, Venezuela, Peru, and other countries. In contrast, the five–page chapter on permanent agriculture focuses on the difficulty of extending the technology of *chinampa* floating gardens to the lowland tropics, while neglecting to elaborate on more promising systems such as terracing, home gardens, and managed forests.

Throughout the book, Clay correctly places the emphasis on our relative ignorance of folk systems of environmental management, and the urgency of continued study in this field. *Indigenous Peoples and Tropical Forests* provides a good introduction, an ambitious program of future research, and a stimulating "call–to–arms" for anyone interested in environmental conservation and the survival of ethnic minorities.

Inquiries on this and other books on indigenous peoples may be directed to: Cultural Survival, Inc., 11 Divinity Avenue, Cambridge, MA 02138.

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BOOK REVIEW

Cornucopia: a Source Book of Edible Plants. Stephen Facciola. Vista, CA: Kampong Publications, 1870 Sunrise Drive, Vista, CA 92084, 1990. Pp. ix, 676. $35.00 (paper). ISBN 0–9628087–0–9.

Not since Hedrick's publication of *Sturtevant's Notes on Edible Plants* in 1919 has such a widely valuable and broadly treated contribution on food plants appeared.

Cornucopia discusses more than 3,000 species available in the United States and abroad. As Dr. Noel Vietmeyer states in his preface: "In your hands is one of the most remarkable efforts to come out of the struggle to preserve the genetic diversity of our planet . . . although our modern food supply is one of the most remarkable of human achievements and new technologies promise even greater harvests in the future, there exist thousands of wondrous resources of which we have taken little advantage. It is research work like that of Stephen Facciola that will help scientists find these resources."

The amount of study and searching on which this volume is based is extraordinarily exhaustive. It has been written as an authoritative reference book, but it can reach a wide readership of not only scientists and agricultural specialists but even popular audiences, including cooks, natural food enthusiasts, and those in gourmet food businesses; it is equally useful as an educational tool in university courses in nutrition and economic botany.

The long table of contents begins with a section on Botanical Listings including plant families, fungi families, algae families, and bacterial families. There follows a listing of Cultivars, including 112 different commercially important plants. A most useful and novel section on Sources includes domestic, domestic non-commercial, overseas commercial, and overseas non-commercial.

The next section—Index of Usage and Edible Parts—offers a mine of easily available information often rather difficult to find in many books. Fifty-eight listings are divided between Adjuvants (substances or plant parts that are usually added to other useful species) to Yeasts Hosts [and] Fermentative Organism Hosts.

Three indices are provided: an Index of Species Native to or Naturalized in North America; Species not listed in Kunkel's excellent *Plants for Human Consumption* (1984); and Families and Genera. Two appendices give Abbreviations Used and Endnotes Used in the Cultivar Listings.

The author deserves a round of grateful applause from a great variety of people who will use this book. The Kampong Publications will be thanked by many a user for offering such a magnificent contribution to economic botany.

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INTERACTION BETWEEN ISLAND FOXES *(Urocyon littoralis)* AND NATIVE AMERICANS ON ISLANDS OFF THE COAST OF SOUTHERN CALIFORNIA: II. ETHNOGRAPHIC, ARCHAEOLOGICAL, AND HISTORICAL EVIDENCE

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ABSTRACT.—Interactions which existed between Native Americans and island foxes *(Urocyon littoralis)* were examined using data gathered from archaeological, ethnographic, and ethnohistoric sources to ascertain how Native Americans viewed and used foxes and thus why they transported and introduced them to islands off the coast of southern California. Island foxes were harvested for their pelts which were used to make arrow-quivers, capes, blankets, and ceremonial fox dance headdresses. Although foxes were not an important staple in the diet of the inhabitants of the Channel Islands, they were kept as pets or semi-domesticates and did play a prominent role in religious and ceremonial practices. The Island Chumash conducted an Island Fox Dance ceremony and foxes served as totems, dream-helpers, and characters in Chumash legends. Human-fox burial associations and ceremonial fox burials attest to the religious and ceremonial significance afforded foxes by Native Americans. I conclude, based on this data, that island foxes from the Northern Channel Islands were initially transported as pets and subsequently became feral on the Southern Channel Islands.

RESUMEN.—Se examinaron las interacciones que existían entre los indígenas y los zorros isleños *(Urocyon littoralis)*, empleando información recogida de fuentes arqueológicas, etnográficas y etnohistóricas para averiguar cómo percibían y utilizaban los indígenas a los zorros y así entender por qué los transportaron e introdujeron a algunas islas frente a la costa del sur de California. Los zorros isleños eran prendidos por sus pieles, que eran empleadas para elaborar aljabas, capas, cobijas y tocados ceremoniales para la danza del zorro. Aunque los zorros no eran un alimento importante en la dieta de los indígenas de las Islas del Canal, eran criados como mascotás o animales semidomesticados y jugaban un papel prominente en las practicas religiosas y ceremoniales. Los indígenas Chumash de las islas ejecutaban una danza ceremonial del zorro isleño, y los zorros servían de tótems, ayudantes en sueños y protagonistas de las leyendas. Los entierros asociados de humanos y zorros, y los entierros ceremonioles de zorros, asestignan la importancia religiosa y ceremonial que los indígenos le conferían a los zorros. Concluyo, en base a estos datos, que los zorros isleños de las islas del norte del Canal inicialmente fueron transportados como mascotas y posteriormente se asilvestraron en las islas sureñas del Canal.

RESUME.—Les interactions qui existaient entre les indigènes et les renards insulaires *(Urocyon littoralis)* ont été examinées en utilisant des données issues

de sources archéologiques, ethnographiques et ethnohistoriques pour vérifier comment les indigènes percevaient et utilisaient les renards, ainsi que la raison de leur transport et de leur introduction dans les îles de la côte due Sud de la Californie. Les renards insulaires étaient chassés pour leurs peaux, utilisées pour fabriquer des porte–flèches, capes et couvertures, ainsi que des coiffures rituelles lors de la danse qui leur était consacrée. Bien que les renards ne faisaient pas partie de la nourriture de base des indigènes qui habitaient les Iles du Detroit, ils étaient maintenus comme animaux domestiques ou animaux semi–domestiques, et jouaient un rôle proéminent dans les pratiques religieuses et rituelles. Les indigènes Chumash des Iles avaient une cérémonie appelée "la danse des renards insulaires," et les renards servaient de totems, de 'support–de–rêves' et de personnages dans les lègendes des Chumash. Les associations funèbres entre les humains et les renards, et les funérailles rituelles des renards montrent la signification religieuse et rituelle attribuée aux renards par les indigènes. Sur la base de ces données, je conclus que les renards insulaires de Iles du Detroit septentrionales ont été transportés à l'origine comme animaux domestiques et ensuite sont retournés a l'état sauvage dans les Iles du Detroit meridionales.

INTRODUCTION

Skeletal remains of native animals found in archaeological sites have been of interest to archaeologists and zoologists alike. Archaeologists examine faunal remains to (1) make inferences about the dietary habits of a site's former occupants, (2) obtain information about several aspects of Native American subsistence activities such as hunting and butchering techniques, areas of procurement, and details of storage, preservation, and food preparation techniques, and (3) examine settlement patterns, activity areas, seasonal occupation of sites, subsistence adaptations, and aspects of the social organization of a site's former occupants (Martin 1972). Faunal material recovered from archaeological sites can also be used to examine questions not originally envisioned by the archaeologist. Zoologists have used faunal material to clarify the zoogeographic history and taxonomy of particular taxa (Rea 1980; Collins 1982, 1992; Lyman 1983), to demonstrate human–wrought changes in animal populations such as insular extirpations and introductions (Hargrave 1970; Guthrie 1980; Walker 1980; Collins 1982, 1991; Olson 1982; Olson and James 1982a, 1982b, 1984; Simons 1983; Rea 1986), and to reconstruct paleoenvironments (Grayson 1981). By combining information contained in the archaeological record with data from the ethnohistoric and ethnographic literature it should be possible to develop a more thorough understanding of how Native Americans viewed and used particular animals. Simons's (1983) article on the California condor provides an excellent example of just such a study.

The island fox *(Urocyon littoralis)* is presently found on six widely separated islands off the coast of southern California (Hall 1981). Morphological variation and taxonomic affinities with its purported mainland ancestor, the gray fox *(U. cinereoargenteus),* have been assessed by Collins (1982, 1992). In a recent paper I examined the role which Native Americans played in establishing island foxes on some of the islands where they presently occur and discussed probable historical colonization sequences for each island population (Collins 1991). The

morphological variation in present-day and archaeological samples, coupled with an examination of island fox remains from Channel Island archaeological sites, revealed that Native Americans were responsible for introducing island foxes from the Northern Channel Islands to the Southern Channel Islands (Collins 1991). Based on archaeological data I determined that island foxes were present on the Northern Channel Islands prior to the arrival of human populations 9000–10,000 years ago but did not appear on the Southern Channel Islands until much later (about 2200 years ago on San Nicolas Island, 3400–3800 years ago on San Clemente Island, and sometime between 800 and 3400 years ago on Santa Catalina Island) (Collins 1991). The occurrence of island fox remains in direct association with human remains on Santa Rosa and Santa Cruz Islands led me to conclude that foxes on these two islands were given special mortuary treatment because they were assigned religious or ceremonial value. I also found a number of island fox burials on San Clemente Island which were probably associated with canid killing or mourning ceremonies (Collins 1991).

While the morphological variation, evolutionary relationships, and archaeological record of island foxes have been thoroughly examined (Collins 1982, 1991, 1992), questions still persist. Why would Native Americans want to transport and introduce island foxes? Could the archaeological and ethnographic record shed light upon prehistoric interactions between humans and island foxes? Were island foxes kept as pets or utilized in human subsistence activities? What cultural and/or religious significance did Native Americans assign island foxes?

Information in the archaeological, ethnographic, and historic records regarding interactions between Native Americans and island foxes has not been fully evaluated. Therefore, the primary objective of this paper is to document through the use of these records any prehistoric interactions between humans and island foxes that might indicate why Native Americans influenced the zoogeography of the island fox.

METHODS

To evaluate prehistoric interactions between Native Americans and island foxes, I have assembled data from the archaeological record and from historic and ethnographic literature. Archaeological manifestations of island foxes included unmodified remains, intentional fox burials, and artifacts fashioned from hides. Faunal material from Channel Island archaeological sites was examined for island fox bone. I recorded the type and quantity of fox bone found at each site and noted the provenience of each occurrence (Collins 1991). In addition, I examined each bone for evidence of possible cultural modifications such as butchering, burning, unusual breakage, and/or manufacturing marks, to determine whether a bone was derived from cultural or natural depositional processes. Archaeological occurrences of unmodified remains and intentional fox burials are discussed in an earlier paper (Collins 1991).

Historic and ethnographic literature for tribes in central and southern California was examined to determine the role of foxes in indigenous cultures. In particular I looked for information relative to foxes being used as a source of food and/or pelts, for manufacture of artifacts, as pets or semidomesticates, and in

religious and/or ceremonial functions. This literature review primarily focused on the Chumash and Gabrielino Indian tribes that inhabited the Channel Islands region (Fig. 1).

There are a number of questions which need to be discussed in considering the role which Native Americans played in determining the present far-flung distribution of the island fox. First, what tribes were present on the islands? Second, how long have humans been present on each of the islands and therefore potentially capable of influencing the distribution of island foxes? Third, were there established trade routes between the islands which could have served as routes for the transport of island foxes? Fourth, what cultural factors influenced people to transport island foxes? Were they kept as pets, or as an alternative source of food or pelts? Were they afforded any special religious or ceremonial significance?

In the following discussion, archaeological, historic, and ethnographic data are used to shed light upon prehistoric interactions between Native Americans and island foxes and to suggest why Native Americans assisted in the dispersal of island foxes.

THE PEOPLE

Based on studies of human osteology, Titus (1987) argues that the islands off the coast of southern California were inhabited over time by two distinct groups

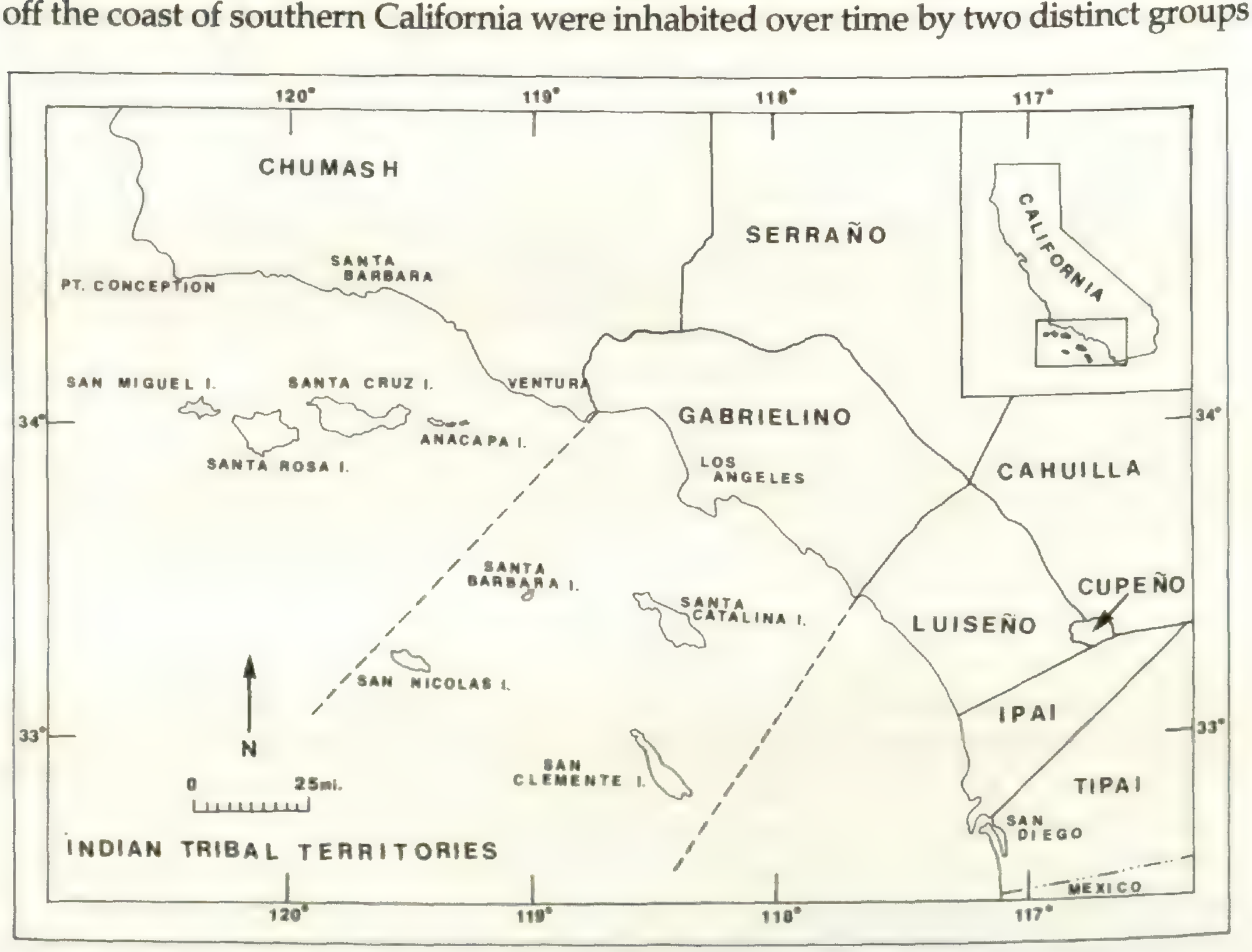

FIG. 1.—Map of the generalized distribution of tribal territories in southern California. This is a composite map which is based on maps contained in Hudson and Blackburn (1985), Salls (1988), and Salls and Hale (1991).

of people. During the Early Period (7500 to 3500 B.P.), all of the islands were inhabited by a single group of people from a "round-headed" genetic population, possibly representing an earlier Hokan stock (Titus 1987). By 1500 B.P., Titus (1987) found that this "round-headed" stock was replaced on San Clemente Island by a new "long-headed" genetic population assumed to represent a Uto-Aztecan intrusion. Titus (1987) suggests that these "long-headed" people were probably ancestors of the Gabrielino Indians that inhabited the Los Angeles Basin and the Southern Channel Islands during the last two to three millenia.

Since the Middle Period (3500 to 800 B.P.), the islands off the coast of southern California were inhabited by tribes belonging to two distinct language stocks. The Northern Channel Islands (San Miguel, Santa Rosa, and Santa Cruz) were in Chumash territory (Fig. 1; Grant 1978; Johnson 1988a) and were associated with the Hokan linguistic stock (Shipley 1978). The Southern Channel Islands (Santa Barbara, San Nicolas, Santa Catalina, and San Clemente) were in Gabrielino territory (Fig. 1; Bean and Smith 1978; Johnson 1988b) and were associated with the Takic family of the Uto-Aztecan linguistic stock (Shipley 1978). While it is known that Santa Catalina and San Clemente Islands were inhabited by Gabrielino Indians (Kroeber 1925; Bean and Smith 1978; Johnson 1988b), the tribal affinities of Indians on San Nicolas Island have not been firmly established as their populations had been depleted before ethnographers could record any substantive information (Salls and Hale 1991). The inhabitants of San Nicolas Island apparently spoke a unique dialect (Kroeber 1907) which probably was affiliated with the Takic family of the Uto-Aztecan linguistic stock (Shipley 1978). Thus, based on linguistic evidence, it is probable that San Nicolas Island was inhabited by people of Gabrielino descent.

Although the Northern and Southern Channel Islands were inhabited during the Middle and Late Periods (800 to 120 B.P.) by tribes from different language stocks, their material cultures have appeared similar to some archaeologists who have referred to archaeological remains from both areas as "Canalino" (Salls 1988). Trade between these two island groups was frequent throughout their occupation (King 1976, 1982). The recovery of island fox skeletal remains at the Eel Point Site (SCII-43C) below a level that was radiocarbon dated at 3400 B.P. (Collins 1991), coupled with the fact that "round-headed" people (i.e., pre-Hokan stock) were present on San Clemente Island around 3000 B.P. (Titus 1987), suggests that foxes were probably first transported to San Clemente Island by peoples belonging to an earlier Hokan stock. Thus, island foxes were present on the Southern Channel Islands prior to the arrival of populations of Uto-Aztecan stock.

History of Native American Occupation of the Southern California Islands.—There is still controversy about when humans first arrived in coastal California and thus when each of the Channel Islands were first inhabited. Some authors (Berger and Orr 1966; Orr and Berger 1966; Orr 1968; Bryan 1978; Davis 1978) have suggested that humans may have reached the New World as early as 30,000 to 40,000 B.P. However, most of the evidence used to support a late Pleistocene colonization of the New World is either of unsubstantiated cultural origin, or is circumstantial or unclear (Glassow 1980). Although human presence prior to the end of the

Pleistocene continues to be debated, today the majority of archaeologists agree that widespread occupation of North America did not occur until about 11,500 years ago (Haynes 1976). It can be assumed that humans came to California shortly after their initial arrival in North America.

Reliable radiocarbon dates associated with human occupation suggest a terminal Pleistocene occupation of the Channel Islands at about 9000 to 10,000 B.P. The earliest currently accepted date obtained so far for human activity on the Northern Channel Islands is an uncorrected radiocarbon date of 10,260 ± 90 years B.P. obtained from the Daisy Cave site (SMI-261) on San Miguel Island (Snethkamp 1986). Early radiocarbon dates on Santa Rosa Island have been obtained at Arlington Springs (SRI-173)—10,080 ± 810 years B.P.—and at Lobo Canyon (SRI-116)—7650 ± 580 years B.P.—(Berger and Protsch 1989). A human burial at Lobo Canyon (SRI-116) was dated at more than 8700 years B.P. (Morris 1987). The earliest accepted dated occurrence for humans on Santa Cruz Island comes from a corrected radiocarbon date of 7500 years B.P. obtained at the Punta Arena site (SCrI-109; Erlandson 1988). Thus, the Northern Channel Islands were inhabited by Native Americans by 9000 to 10,000 years ago.

During the last decade several radiocarbon dates have established human occupation of the Southern Channel Islands by about 9700 years ago (Salls 1988). On San Clemente Island the earliest charcoal-based radiocarbon dates ranged from 9775 ± 165 to 9870 ± 770 years B.P. for SClI-43B (Erlandson 1988). The earliest radiocarbon date for human occupation on San Nicolas Island, obtained from a midden at SNI-339, is 8215 ± 85 years B.P. (reservoir-adjusted to be 8000 years B.P.) (Salls 1988). Further archaeological research on Santa Catalina Island is needed to determine whether this island was inhabited as early as the other Southern Channel Islands.

Thus, there is reasonably accurate evidence to suggest that humans have been present on islands off the coast of southern California for at least the last 8000 to 9000 years and possibly as long as 10,000 years. Therefore, they could have been influencing the distribution of island foxes in this region at least since the end of the Pleistocene.

Native American trade routes.—There is abundant evidence establishing the existence of trade in resources and manufactured goods, both between islands and mainland, and among the islands (King 1976; Hudson 1976; Tartaglia 1976; Hudson et al. 1978). Ethnohistoric accounts describe Chumash canoe trips between the Northern Channel Islands and the adjacent mainland and between islands (Hudson et al. 1978). The mainland Chumash traded roots, seeds, acorns, milkweed fiber, furs, skins, shawls of fox skin, blankets, deer, bows, and arrows to their island counterparts in return for shell, "coral," and fish bone beads, abalone shell, fish, marine mammal meat, sea otter pelts, and other items (King 1976; Hudson 1976; Tartaglia 1976; Hudson et al. 1978).

Other evidence of mainland-to-island and island-to-island trade can be found in the distribution of goods manufactured on the islands, such as objects made of steatite (soapstone), and shell. Many of the steatite bowls, *ollas,* and *comals* found throughout southern California appear to have originated from Gabrielino

quarries on Santa Catalina Island (Heizer and Treganza 1944; Meighan and Johnson 1957; Meighan 1959; Wlodarski 1979). Steatite artifacts have also been reported from most of the Channel Islands including San Clemente (McKusick and Warren 1959), San Nicolas (Bowers 1890; Bryan 1930, 1970), Santa Cruz (Rogers 1929), and Santa Rosa Islands (Orr 1968). Mainland sites situated along the coastal zone throughout southern California have also produced many examples of steatite artifacts (Meighan and Rootenberg 1957; Finnerty et al. 1970). Shell bead money was also a significant item of trade (King 1991). Island Chumash specialized in the manufacture of shell bead money and shell ornaments (King 1976, 1982). These objects were widely distributed throughout southern California, reaching as far east as sites in Arizona (Glassow 1980).

The exact dates when intensive trade of manufactured goods for natural resources began have not yet been firmly established. Several authors have suggested that manufacturing was frequently engaged in by islanders after A.D. 1000 (Meighan and Rootenberg 1957; Meighan 1959; Wlodarski 1979; Glassow 1980; King 1991), but trade of manufactured goods and natural resources did occur earlier with less intensity (King 1982). Although quarrying, manufacturing, and exchange of soapstone objects from Santa Catalina Island began more than 4000 years ago, large-scale production and exchange of this island-manufactured resource was restricted to the last 500 to 700 years (Wlodarski 1979). Since island fox bone first appears in the archaeological record on San Clemente Island around 3400 B.P., and on San Nicolas Island around 2200 B.P. (Collins 1991), island foxes were probably transported to the Southern Channel Islands prior to the period of intensive inter-island trade of manufactured goods.

In summary, the presence of island-manufactured shell bead money and quarried steatite in mainland and island sites, mainland quarried serpentine bead blanks in early Santa Cruz Island sites, obsidian in early contexts on all the islands, and non-native mammal bone (i.e., mule deer and domestic dog) in island archaeological contexts, firmly establishes the existence of trade both among the islands and between the islands and the mainland (King 1982). Santa Cruz, Santa Catalina, and San Clemente Islands each had established trade routes with the adjacent mainland (Davis 1961). Trade routes also existed between Santa Cruz and Santa Catalina Islands, and between islands within each of the island groups (Davis 1961). Thus, it is possible that people could have transported foxes to some of the offshore islands. Moreover, since trade occurred between the Northern and Southern Channel Islands, a possible route of introduction may well have followed this direction (i.e., Santa Cruz to Santa Catalina or San Clemente Island and then to San Nicolas Island).

ARCHAEOLOGICAL RECORDS OF ISLAND FOXES IN PREHISTORIC SITES ON THE CHANNEL ISLANDS

In a previous paper, I provide a detailed record of the archaeological occurrence of island foxes (Collins 1991). A brief summary of these results is warranted here.

Archaeological manifestations of island foxes included unmodified remains and intentional burials. Island foxes were found in 27 archaeological sites and

one fossil locality on the six largest islands off the coast of southern California. Unmodified fox remains were present in sites which ranged in age from 7500 B.P. (Santa Cruz and Santa Rosa Islands) to historic times (all six islands). On the Southern Channel Islands, foxes first appear in the archaeological record about 3400 to 3800 B.P. on San Clemente Island, 800 to 3400 B.P. on Santa Catalina Island and 2200 B.P. on San Nicolas Island (Collins 1991). Island fox bone has yet to be recorded from any Early Period sites on the Southern Channel Islands. Foxes were found throughout human occupation on Santa Cruz and Santa Rosa islands and were present beginning in Middle through Late Period sites on San Miguel Island. A fossil island fox skull recovered from a geological formation on Santa Rosa Island dating between 10,400 and 16,000 years suggests that foxes were present on that island prior to the arrival of Native Americans 9000 to 10,000 years ago.

Remains of 51 island foxes that appear to have been intentionally buried were found at 12 sites on four of the Channel Islands (Table 1). Foxes were found in direct association with human remains on Santa Cruz Island, and possibly in direct association with human remains in cemeteries on Santa Rosa Island (Table 1; Collins 1991). Burials of foxes not in association with human remains were found on Santa Cruz, San Nicolas, and San Clemente Islands. Of 10 fox burials found on San Clemente Island, seven were pups and three were associated with grave goods. Nine of the 10 fox burials contained solitary foxes that were folded head to tail and each stuffed vertically, dorsal surface down, into individual grave pits (Fig. 2; Salls and Hale 1991). There appear to be differences in fox burial patterns between the Northern and Southern Channel Islands, the possible reasons for which are discussed later in this paper.

The use of foxes in human subsistence activities.—One of the interaction patterns between island foxes and Native Americans was the use of foxes in human subsistence activities. Foxes could have been harvested for food or pelts, or kept as pets or semidomesticates.

The use of foxes as a source of food. Nine tribes in central and northern California were known to eat gray foxes (Driver 1937; Voegelin 1942). In southern California, the mainland and island Gabrielino and Chumash, Kitanemuk, Serraño, and Colorado River Yumans occasionally ate foxes (Harrington 1942; Landberg 1965; Martin 1972; Rea 1981). Six tribes in northern California, one in central California (Tubatulabal), and one in southern California (Luiseño) refrained from eating gray fox (Drucker 1937; Voegelin 1938, 1942). Thus, ethnographic sources indicate that foxes were not an important food source for most California peoples.

The virtual absence of fox bones from archaeological sites throughout California also suggests that foxes were not a staple in the diet of any California Indian tribe (Collins 1982). Gray fox remains are scarce in mainland Gabrielino and Chumash sites. Gabrielino sites which have recorded gray fox include Ora-193 (Langenwalter 1981), Big Tujunga LAn-167 (Martin 1972; Langenwalter 1978), and Mulholland LAn-246 (Galdikas-Brindamour 1970). An unnamed site north of Agoura (Ven-39) is the only mainland Chumash site in which gray fox have

TABLE 1.—Island fox burials with ritual or ceremonial connotations.

Island[1]	Site No.[2]	Provenience	Material Present	Age	Type of Association
SRI	1	Cemetery A, Burial 1	4 complete skulls	Ads.	Human cemetery
SRI	2A	Cemetery A, Burial 4, Level 2	5 partial skulls	Ads.	Human cemetery
SRI	2A	Cemetery A, Plot C-2	1 complete skeleton	Ad.	Human cemetery
SRI	2B	Cemetery B, Trench B	3 partial skulls	Ads.	Human cemetery
SRI	41	Cemetery C, Section II	1 skull	Ad.	Human cemetery
SCrI	3		1 complete skeleton	Ad.	Human cemetery
SCrI	8	Pit DD-1, 3′	1 skull	Ad.	Human burial
SCrI	100	Pit D-5	2 skulls	Ads.	Human burial
SCrI	131	Pit 4, 3′-5′ 2″	2 skulls	Ads.	Human burial
SCrI	?		1 skull	Ad.	Ritual burial with grave goods
SNI	7		20 complete/partial skeletons	Ads.	Ritual burial?
SClI	43C	Unit 4, 160-175cm, Feature D	2 complete skeletons	Pups	Ritual burial with beads
SClI	43C	Unit 6, 175-190cm, Feature O	1 partial skeleton	Ad.	Ritual burial
SClI	1215	Unit 4-5, W10, 50-60cm	1 partial skeleton	Ad.	Ritual burial?
SClI	1524	Unit 7S/15E, 20-30cm, Feature F6	1 skeleton	Pup	Ritual burial with grave goods
SClI	1524	Unit 7S/17E, 10-20cm, Feature 125	1 skeleton	Ad.	Ritual burial
SClI	1524	Unit 8S/17E, 15-18cm, Feature 96	1 skeleton	Pup	Ritual burial
SClI	1524	Unit 13S/15E, 30-40cm, Feature 48	1 skeleton	Pup	Ritual burial with grave goods
SClI	1524	Unit 13S/19E, 30-40cm, Feature 140	1 skeleton	Pup	Ritual burial
SClI	1524	Unit 17S/OW, 15-30cm, Feature 109	1 skeleton	Pup	Ritual burial

1. Locality acronyms are as follows: SRI = Santa Rosa Island; SCrI = Santa Cruz Island; SNI = San Nicolas Island; SClI = San Clemente Island.

2. University of California-Berkeley (UCB) site numbers are used for Santa Cruz Island while University of California-Los Angeles (UCLA) site numbers are used for the rest of the islands. For site concordance of the Santa Cruz and Santa Rosa Island sites with other numbering systems see Glassow (1977).

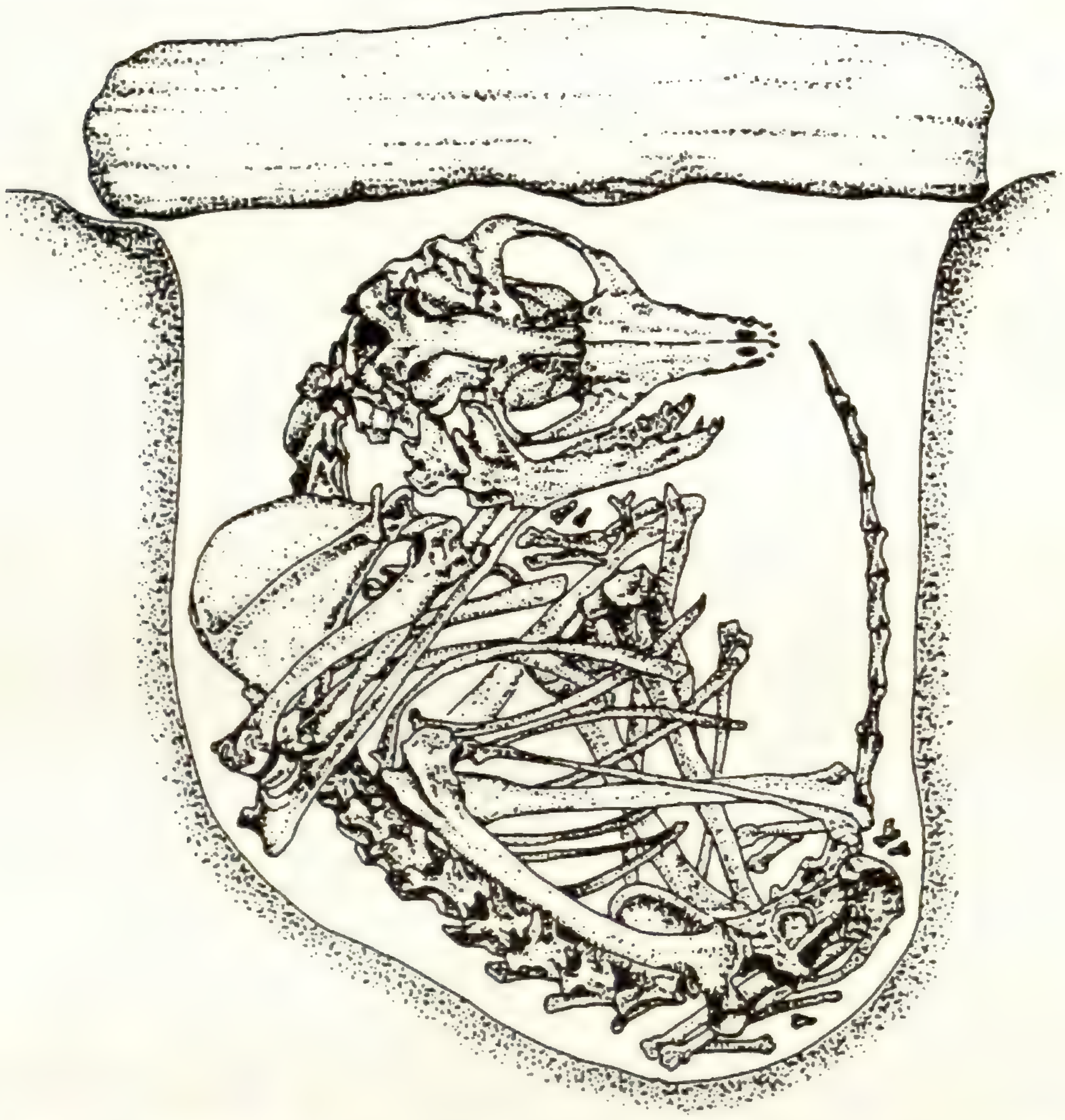

FIG. 2.—Typical example of the folded head to tail orientations observed in ritual island fox burials recovered from the Lemon Tank Site on San Clemente Island (SCII-1542) (From Salls and Hale 1991, by permission).

been recorded (Martin 1972). Unmodified fox remains were rare at these sites (one to three specimens at each). The scant archaeological evidence of foxes in mainland sites suggests that there was a cultural preference not to eat fox regularly. In general, analysis of faunal remains from Chumash and Gabrielino sites indicates that all of the coastal and island peoples tended to utilize marine animals such as fish, shellfish, and marine mammals extensively, while land animals were of lesser importance (Landberg 1965; Glassow 1980).

Island foxes have not yet been recovered from any mainland archaeological sites in southern California. Remains of island foxes are far more abundant in Channel Island archaeological sites than gray foxes are in mainland sites (Collins 1991). A combination of factors is probably responsible for this situation. Island fox populations exhibit higher population densities than mainland gray fox populations (Laughrin 1980), are more diurnally active (Fausett 1982), and show a general lack of fear of humans (Laughrin 1977). These factors, probably the result of

reduced competition and absence of predators (Laughrin 1977), would tend to make foxes on the islands more readily available to humans as an emergency source of food or as a dependable source of pelts.

If foxes were regularly eaten, then their skeletal remains should show cultural modifications consistent with this type of use. Limb elements should have been broken for the extraction of marrow, skulls should have been broken for the removal of brains, and there should have been a significant number of burned or calcined bones. Examination of archaeologically–recovered island fox bones for butcher marks, fragmentation of long bones, and charring, however, revealed little evidence that foxes were being harvested as a food source or that their bones were being used for manufacturing artifacts. The only evidence of cultural modifications on island fox bones found during this study was one burned ulna recovered from San Miguel Island by Walker and Snethkamp (1984) and butcher marks on five skulls recovered from San Nicolas, Santa Rosa, and Santa Cruz Islands (Collins 1982). The charred ulna does not confirm that a fox was consumed by the inhabitants but might suggest that a fox bone was accidentally burned in a fire. The locations of the butcher marks suggest that people were skinning foxes for their pelts, as discussed in the next section. From the archaeological record it seems reasonable to conclude that island foxes were rarely if ever eaten by Native Americans on the Channel Islands and as such were probably not transported to the southern islands to serve as an alternative source of food. Nonetheless, the abundance of island fox remains in archaeological contexts suggest that island inhabitants may have placed special value on foxes either as a source of pelts, as pets, or for use in religious and ceremonial practices.

Use of foxes as a source of pelts. Ethnographic and historic accounts from several California Indian tribes mention that gray foxes were hunted for their pelts, which were used to make arrow quivers, capes, blankets, and portions of costumes. Tribes which made arrow quivers from gray fox pelts included Hupa (Beals and Hester 1974), Sierra Miwok (Barrett and Gifford 1933), southern California Luiseno (Drucker 1937), Chumash (Harrington 1942), Kitanemuk (Hudson and Blackburn 1982), and Gabrielino (Harrington 1942; Heizer 1970). There is no information about Island Chumash arrow quivers, but since they were known to use arrows the islanders may have used island fox skins to construct quivers (Hudson and Blackburn 1982).

Mainland Chumash were known to value "shawls" (Spanish: *tapalos)* made of fox skins which they exchanged with island Chumash for fish and beadwork (King 1976). Harrington recorded extensive ethnographic data concerning Chumash, Kitanemuk, and Gabrielino use of fox skins for making sewn and woven capes and blankets (Hudson and Blackburn 1983, 1985). According to Fernando Librado, one of Harrington's consultants, the Santa Cruz Island Chumash "preferred to wear a fox skin blanket as big as a bed quilt to other ones. It would take many skins, cut into strips three inches wide and sewn together, to make such a blanket" (Hudson and Blackburn 1983:385). Early explorers have described hide capes, cloaks, and robes made of animal fur which were worn by coastal Chumash. Longinos Martínez reported in 1792 that "from the waist

up they [the women] wear [a garment] of fox, otter, squirrel, or rabbit fur oblong in shape and very comfortable'' (Simpson 1961:53). In 1792, Menzies wrote that the men ''put on a kind of garment made of fox or raccoon skins with the fur side out'' (Eastwood 1924:315, 324). Thus, the Chumash either sewed fox hides together edge to edge or cut them into strips which they twisted or wove together to make capes and/or blankets. To make a single blanket or a large cape would require many island fox skins. This might explain the occurrence of 20 island fox skeletons recovered by Orr during one morning of excavation at a site (SNI–7) on San Nicolas Island (Table 1; Orr 1945).

Mainland and Island Chumash also used fox skins in ceremonies, particularly in the form of a headdress worn by dancers performing the Fox Dance (Hudson and Blackburn 1985). These headdresses were constructed of a woven frame covered by fox skin or some other animal skin. Some ''had a real fox head sticking out in front of the headdress'' (Hudson and Blackburn 1985:195). Island fox pelts were probably used by Island Chumash to adorn their Fox Dance headdresses. Although the Fox Dance was primarily associated with the Island Chumash, it was also performed at *fiestas* held at mainland Chumash villages (Hudson and Blackburn 1985).

If the entire fox skin was being removed intact, butcher marks would probably have been left on bones near the anterior portion of the rostrum, since this is an area of the body where the skin adheres to the bone. However, if the head and legs were cut off the carcass prior to skinning as among the Central Miwok (Barrett and Gifford 1933) and Tarahumar (Pennington 1969), then butcher marks should appear on the posterior margin of the skull, the occipital condyles, the cervical vertebrae, or the distal ends of the long bones. All butcher marks found on island fox bones recovered from Channel Island archaeological sites occurred across the anterior portion of the rostrum and mandible. This suggests that Chumash and Gabrielino Indians were skinning island foxes whole for their pelts. The absence of butcher marks from other island fox skeletal elements either suggests that foxes were not being butchered for use as food or indicates the ability to skin foxes without cutting into the bone.

In summary, ethnographic and historic literature and archaeological data suggest that Chumash and Gabrielino Indians hunted gray fox and island fox for their skins and that these skins were used to manufacture arrow quivers, capes, blankets, and ceremonial fox dance headdresses. Island foxes could have been taken to the Southern Channel Islands to provide the island inhabitants with a source of foxes to be used for making these items. Although there is no evidence that Gabrielino Indians on the Southern Channel Islands performed the Fox Dance, if they did then island fox pelts would have been necessary to construct the headdresses used. Alternatively, Chumash islanders may have traded already prepared headdresses or unprocessed fox pelts for soapstone or other needed raw materials rather than transport and trade live foxes.

Use of foxes as pets or semidomesticates. Island foxes are characterized by fearless and inquisitive behavior, high population densities, and diurnal activity patterns. These factors would have made them readily accessible for possible

domestication and transport. Since the island fox is easily tamed, it could make an excellent pet (Wenner & Johnson 1980). Indeed, "with a little coaxing the fox becomes sociable and one often wonders how this animal had survived through heavy Indian habitation if they were not friendly toward it" (Smith 1977:41).

Dogs were the only animals known to have been regularly kept as pets by California Indians (Kroeber 1941). Occasionally, bears, condors, eagles, hawks, and ravens may also have been kept as pets by California tribes including the Chumash. There are no ethnographic or ethnohistoric accounts documenting that Chumash or Gabrielino Indians kept foxes as pets. Island fox burials found with humans on Santa Cruz Island and in human cemeteries on Santa Rosa Island (Table 1) suggest two possible explanations: (1) that island foxes may have been kept as pets and were given special burial considerations upon their death or the death of their masters, or (2) that foxes may have been associated with special ceremonies or rituals and as such were given special burial considerations. To determine whether island fox burials are the result of animals kept as pets, or are the result of religious or ceremonial practices, ethnographic and archaeological data were gathered on how California Indians used and disposed of their pet dogs.

Ethnographic data concerning the possible uses of dogs by the Chumash and Gabrielino is limited, though both groups kept them as pets and were known to eat them occasionally (Kroeber 1925, 1941; Harrington 1942). For the Gabrielino, dogs "were valued animals and are believed to have been most likely buried like humans as a method of working out grief resulting from the dissolution of the owner–pet bond at death, rather than for religious or ceremonial purposes" (Langenwalter 1986:65). Dogs could also have been buried for supernatural reasons, such as to help guide the deceased in their journey to the Land of the Dead. According to Bean and Smith (1978) the Island Gabrielino had a custom of burying a dog over the deceased person's body. However, there is no archaeological evidence to confirm this practice nor to confirm that the Chumash or Gabrielino actually practiced pet killings and interment of pets with their masters (King 1969). This practice has been recorded for a number of other California tribes including the Miwok (Aginsky 1943), Yokuts (Driver 1937), and Nisenan (Beals 1933).

Domestic dog remains have been found in archaeological sites throughout southern California and on the Channel Islands, evidence that Native Americans kept dogs as pets and transported them in watercraft (Schumacher 1877; Bowers 1890; Rogers 1929). While dog burials are a relatively common occurrence among the Chumash and Gabrielino (Johnston 1962; Landberg 1965; Langenwalter 1978, 1986; Salls and Hale 1991), their burial in direct context with humans or with burial goods is much less common (Rogers 1929; Titus 1984; Langenwalter 1985, 1986; Reynolds 1985). On San Nicolas Island, dog burials have been found in several human cemeteries, but none were in direct association with human remains, nor was there any evidence of violence to suggest that they might have been sacrificial burials (Orr 1945; Orr and Rett 1945).

Several dog burials from the Channel Islands do suggest rituals related to religious practices. A ceremonial burial of a dog which had been wrapped in sea otter skin was found in Big Dog Cave on San Clemente Island (McKusick and

Warren 1959). A number of dog burials, several of them adorned with grave goods, were recovered in 1983 from San Clemente Island at the Eel Point site (SClI–43) (Titus 1984) and in 1988 and 1989 at the Lemon Tank site (SC1I–1524); these could be related to a canid killing ceremony possibly associated with Chingichngish religious practices such as mourning or burial ceremonies (Salls and Hale 1991).

It appears from the ethnographic and archaeological record that Chumash and Gabrielino Indians generally buried their pets but that they only occasionally buried them with artifacts or in direct association with human burials. If island foxes were being kept as pets on some of the islands, then I would expect to find their remains in contexts similar to those recorded for dog burials. Indeed, a number of the fox burials recovered from human cemeteries on the Channel Islands are suggestive of foxes being kept as pets. However, the occurrence of island fox remains in direct association with human burials on Santa Cruz and Santa Rosa Islands and with artifacts on San Clemente Island is probably best explained by island foxes having special religious or ceremonial value, as will be discussed below.

The use of foxes in religious and ceremonial systems.—Another pattern of interaction between island foxes and humans was based upon religious and ceremonial practices. The ethnographic literature for California tribes is particularly rich with descriptions of ceremonial observances and treatments accorded animals (Lillard et al. 1939; Heizer and Hewes 1940; Cowan et al. 1976; Langenwalter 1986). Archaeological occurrences of intentional animal burials as well as artifacts fabricated from animal parts help document special attitudes toward animals. By examining how the Chumash and Gabrielino viewed animals it may be possible to understand and interpret unusual archaeological occurrences of island foxes. Several possibilities could account for the occurrence of unusual island fox burials. Island foxes could have been revered as totemic animals and thus been kept as pets by totemic clans. Alternatively, foxes could have been spirit guides to individuals, and as such, body parts of foxes were kept as talismans. Either of these alternatives could account for unusual archaeological occurrences of island foxes or for the presence of island fox remains in direct association with human remains.

Overview of California ritual animal burials. Animal burials suggest the presence of ceremonial activities associated with a particular species. By comparing the archaeological record with ethnographic descriptions of religious and social customs, it is often possible to infer that ceremonial activities were associated with a species. Such analyses also provide a clearer picture of how a native society viewed that species. Burials in which the entire or partial skeleton of an animal is found, either in a cemetery or in direct association with human burials or artifacts, are probably affiliated with rituals or ceremonies.

There are many documented occurrences of ceremonial animal burials (Lillard et al. 1939; Heizer and Hews 1940; Wallace and Lathrop 1959; Gerow and Force 1968; Langenwalter 1986; Salls and Hale 1991). Animals known to have been buried in a ceremonial context include bear, badger, coyote, beaver, deer, dog, and various birds of prey. Some of these may represent an individual human being buried with his hunting trophies, charms, pets, or other personal belong-

ings as part of a mortuary ceremony (Gerow and Force 1968). Many California tribes buried the dead with their personal belongings and with offerings of food and clothing (Kroeber 1925). The Chumash (Landberg 1965) and Gabrielino Indians (Johnston 1962) apparently practiced this custom.

Animal burials, particularly dog burials, were common among the Chumash and Gabrielino. Along the mainland coast ritual animal burials have been recovered from two sites in Chumash territory and from six sites in Gabrielino territory (Langenwalter 1986). A ceremonial eagle burial was recovered from a Chumash site at Point Sal in Santa Barbara County (Carter 1941). A dog burial from a Ventureño Chumash site may represent the burial of a pet (Langenwalter 1978). Thirteen animal interments (one red-tailed hawk and 12 dogs) were recovered from a Gabrielino site (LAn-43) (Langenwalter 1986). There have been no gray fox burials recorded among any California Indian tribes. Thus, based on archaeological and ethnographic records, it does not appear that gray foxes were afforded any special religious or ceremonial status by mainland tribes.

As discussed above, animal burials, particularly dog burials, are relatively common on the Channel Islands. Several articulated bird skeletons were recovered from a site on Santa Cruz Island (Hoover 1971). The ceremonial burial of a dog and two chickens was found in Big Dog Cave on San Clemente Island (McKusick and Warren 1959) and recent excavations on the same island have recovered a number of additional ritual animal burials. Three island fox burials were recovered from the Eel Point Site (SCII-43C) (Titus 1984; Bleitz-Sanburg 1987) while 20 animals burials (7 island fox, 5 dogs, 8 birds) have recently been recovered from the Lemon Tank Site (SCII-1524) (Salls and Hale 1991). To date there have been a total of 51 island fox burials recovered from the Channel Islands (Table 1). At least 31 of these are suggestive of some sort of ceremonial or religious value assigned island foxes.

Ceremonies associated with foxes. Fox ceremonies were not very common among Native Americans. On the Plains, Cheyenne practiced a fox ceremony (Grinnell 1962) while the Pawnee had a Fox Society (Dorsey 1904). In California, the Maidu occasionally used stuffed fox skins as images of the deceased in burning ceremonies (Hill 1972). The fox appears as a character in two Chumash legends, suggesting that foxes played some role in Chumash society (Blackburn 1975). The Island Chumash practiced a Fox Dance which was also performed at *fiestas* on the mainland (Hudson et al. 1977). This dance was apparently associated with island foxes since its songs were sung in Cruzeño, the language of the Chumash on the Channel Islands. Fox burials on Santa Rosa and Santa Cruz Islands are indicative of some ceremonial value assigned island foxes (Collins 1991).

It is unknown whether the Gabrielino had any ceremonies associated with foxes; there are no extant accounts of the Gabrielino practicing a fox dance or having the fox as a prominent character in any legends. Although the ethnographic literature is silent regarding canid ceremonialism on the Southern Channel Islands, archaeological records of intentional fox burials on San Clemente Island (Table 1) suggest the existence of a canid killing or mourning ceremony possibly affiliated

with Toloache rituals and/or Chingichngish religious practices such as adolescent initiation rites, mourning, or eagle-killing ceremonies (Salls and Hale 1991).

The role of foxes in religious systems. Groups who inhabited southern California and the Channel Islands practiced the Toloache religious-ceremonial system (Bean and Vane 1978) which utilized the hallucenogenic plant, jimson weed, *Datura* sp., to help in the "acquisition of supernatural power from sources accessible only during altered states of consciousness" (Simons 1983:480). Several major religious subsystems developed out of the Toloache religious-ceremonial system within southern California: (1) the "Northern Complex" among the Southern Valley Yokuts, Kitanemuk, Tataviam, and Gabrielino peoples, (2) the ***'Antap-Yivar*** religious complex among the Chumash, Gabrielino, and Tataviam peoples, (3) the "Southern Complex" among the Gabrielino and Luiseño-Juaneño peoples, and (4) the Chingichngish religion among Gabrielino, Luiseño-Juaneño, Cupeño, and Ipai-Tipal peoples (Bean and Vane 1978; Hudson and Blackburn 1978; Simons 1983). The Island Chumash belonged to the ***'antap-yivar*** mythic-ritual complex while the Island Gabrielino on San Nicolas, Santa Catalina, and San Clemente Islands may have belonged to several mythic-ritual complexes including the ***'antap-yivar,*** Southern, and Chingichngish religious complexes (Hudson and Blackburn 1978). Each of these religious subsystems was "characterized by elaborately developed tenets, replete with symbolic meanings, and a complex pantheon of supernatural deities and beings. A highly detailed system of ceremonies was overseen by a professional priesthood" (Simons 1983:481).

Examination of these religious-social systems helps in interpreting the occurrence of unusual animal/human burial associations. A number of tribes occupying central and southern California (i.e., Miwok, Mono, Central Yokuts, Salinan, Kitanemuk, Serraño, Cahuilla, Cupeño, Luiseño, Yuma, and Mohave) were known to have had totemic moieties (Gifford 1916; Kroeber 1925; Driver 1937; Gayton 1948; Bean 1976). The Miwok divided all nature into two moieties, Water and Land. Each moiety had a series of animals, plants, or other objects associated with it. In infancy a person received the name of an animal or object from the moiety to which he was born. This object or animal became that individual's totem. Bears, coyotes, and deer were all common totemic animals for the Miwok, Yokuts, and Cahuilla societies. The capture and keeping as a pet of one's totem was common among the Miwok and Yokuts (Kroeber 1925; Driver 1937; Aginsky 1943). The killing and burial of a totemic animal in the same grave with its deceased owner was practiced by the Miwok, Yokuts, and Nisenan. Thus, unusual animal/human burial associations in societies with totemic descent groups could be the combined result of the keeping of one's totem as a pet and the killing and interment of this pet at the death of its owner. This may be a plausible explanation of an unusual burial of a child and a bear in a site along the Sacramento River delta (Cowan et al. 1976). Possession of one's totem or part of one's totem brought with it some of the supernatural powers which were believed to be inherent in the totemic animal. Thus, it is possible that one's totemic animal would be buried with an individual at their death to re-establish their living relationship and thus aid them in their afterlife.

The social and religious structure of Chumash and Gabrielino societies is poorly understood. While there is evidence that the Chumash possessed totemic clans (Johnson 1988a), these clans were probably not divided into a strict moiety system like that present in the Miwok and Yokuts cultures. Some Yokuts, Gabrielino, Kitanemuk, Chumash, and Juaneño are thought to have had pseudo-moieties that functioned in social and ritual activities (Bean 1976). The Chumash did have cults or sodality organizations that were homologous to Gabrielino and Luiseño Chingichngish religious–ceremonial organizations. "Members of this cult were referred to as *'antap* and their primary responsibility seems to have been the performance of dances and other rituals at large public ceremonies. Members were baptized into the cult as children, and through a period of apprenticeship learned the esoteric language, sacred songs and dances and other aspects of ritual that characterized it" (Blackburn 1974:104–105). Large *fiestas,* which transcended ethnic, political, and linguistic boundaries, were sponsored by members of *'antap-yivar* cults (Hudson and Blackburn 1978). The Chumash Fox Dance was usually performed at such large gatherings (Hudson and Blackburn 1985). It is possible that those who performed this dance actually belonged to an *'antap*-like "fox cult" or were members of an Island Chumash Fox Clan. Island foxes could have been revered and kept as pets by members of this fox cult or clan. Upon the death of one of the cult members, special burial considerations may have included the interment of an entire or partial island fox with the dead cult member. This could account for the island fox/human burials recorded on the Northern Channel Islands.

Among tribes in South Central California, including the Chumash and the Gabrielino, individuals made contact with the supernatural by means of a spirit guide, or dream helper. The following discussion comes from Applegate's (1978) synthesis of data on the "dream helper" among southern California Indians. "The supernatural manifests itself in the form of a spirit which appears in a dream or an induced vision—the dream helper. The dream helper speaks to the dreamer, offering him or her power and protection, and gives a talisman and a song—perhaps with instruction in their use—which symbolize the helper and through which it can be evoked. The dreamer takes care to respect and obey his helper; in time of need he can call upon the dream helper and be confident of its support" (Applegate 1978:7). Dream helpers were generally animal spirits, but could also be ghosts or personified natural forces. Dream helpers could come unsought, or could be acquired either through the use of drugs or through techniques such as fasting or night bathing. The Yokuts, Western Mono, and Chumash were the only tribes known to have had foxes as dream helpers. This is not unexpected since larger, more important, and more dangerous animals (i.e., eagle, bear, mountain lion, rattlesnake) are most often mentioned as being dream helpers. However, "less consequential creatures like Fox, Blackbird, Frog, or Lizard" were probably also used as dream helpers by tribes in South Central California (Applegate 1978:20). The only ethnographic evidence to suggest that the Chumash might have had foxes as dream helpers is a statement that one Chumash *'antap* leader had fox as a dream helper (Hudson and Blackburn 1978). Given the abundance and prominence of island foxes on the Channel Islands it is possible that they served as dream helpers for the Island Chumash.

Animal helpers acquired by an individual were distinct from an inherited totemic animal. ''The totem is a social concept, a matter of public knowledge and individuals are free to speak of their totem and to ask strangers of theirs. The totem is inherited patrilineally, imposing certain political, ceremonial, or professional obligations on the individual and giving him in turn certain rights . . . Altogether the dream helper relationship is much more personal and much less formalized than the totemic relationship'' (Applegate 1978:23). One did not have to belong to a particular animal totemic lineage in order to have the same animal as a dream helper. The similarity between the two concepts is in the veneration afforded the totem and the dream helper. An individual would not kill or eat the flesh of his totem or his dream helper.

An essential part of the dream helper complex is the talisman or ***atishwin*** as it was called by the Chumash. ''The talisman is the physical representation of the helper; it not only symbolizes the relationship of an individual to his dream helper, it is an actual channel of power'' (Applegate 1978:53). The talisman can be made of an unusual material object such as a quartz crystal or can be animal parts from one's dream helper. Possession of a talisman was '' . . . believed to confer supernatural power on its owner by linking that individual with a tutelary [=dream helper]'' (Hudson and Blackburn 1986:139). Among the Yokuts and Western Mono arrow quivers made of fox skin were considered talismans (Gayton and Newman 1940). Possession of a portion of one's dream helper (i.e., a talisman) brought with it some of the special limited supernatural powers possessed by that dream helper. Among the Chumash it is not known whether the animal counterpart of one's dream helper was revered and kept as a pet or whether their body parts (i.e., fur, claws, skull, teeth) were kept as talismans. The Chumash believed that when a talisman was magically obtained it was useless except to its owner and was generally buried with him (Applegate 1978). Perhaps an individual was buried with his talisman in order to help him in the journey to the Land of the Dead. Given the abundance of island foxes on the Channel Islands it is not inconceivable that foxes were a common dream helper for the Island Chumash. This provides a plausible explanation for the occurrence on the Northern Channel Islands of island fox remains in direct association with human burials and may help to explain a number of the island fox burials which appear to have ceremonial connotations.

CONCLUSIONS

Information from the archaeological record and from ethnographic and ethnohistoric literature was used to shed light upon interactions between Native Americans and island foxes. Based on this data review, tentative answers can be given to some of the questions asked at the beginning of this paper.

Islands off the coast of southern California have been inhabited by humans for at least the last 9000–10,000 years. In prehistoric times, the Northern and Southern Channel Islands were inhabited by tribes belonging to a single, widely distributed population of Hokan speakers. In more recent times these two island groups were inhabited by tribes belonging to separate language families (i.e.,

Hokan speakers on the Northern Channel Islands and Uto–Aztecan speakers on the Southern Channel Islands). The occurrence of island-manufactured shell bead money and quarried steatite in mainland and island sites firmly establishes the existence of trade both among the islands and between the islands and the mainland. The existence of active trade between the Northern and Southern Channel Islands during prehistoric times provides a mechanism and route by which people could transport island foxes between these two island groups.

In terms of subsistence activities, groups on the Channel Islands harvested island foxes for their pelts which were used to make arrow quivers, capes, blankets, and ceremonial fox dance headdresses. Although island foxes may have occasionally been eaten, they were not an important staple in the diet of Native Americans and therefore were probably not transported or traded to the southern islands to serve as an alternative source of food.

Island foxes did play an important role in religious and ceremonial practices of tribes on the Channel Islands. Archaeological and ethnographic manifestations of this interaction pattern included intentional burials of island foxes, appearance of foxes in Chumash legends, and fabrication of articles from their hides for use in the Island Chumash Fox Dance. Direct human–fox burial associations found on the Northern Channel Islands are probably an indication that an individual had island fox as a totem or dream helper, or that the person belonged to a social group or clan responsible for performing the Island Chumash Fox Dance. The ritual burial of foxes on San Clemente Island suggests the existence of a canid killing ceremony possibly associated with Chingichngish religious practices (e.g., toloache rituals) or with mourning ceremonies (Salls and Hale 1991). Although none of these ritual associations can be adequately substantiated from the ethnographic or ethnohistoric literature, they can be suggested as plausible explanations from what is known regarding Chumash and Gabrielino social structures and religious beliefs.

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FAMINE FOODS OF THE NORTHERN AMERICAN DESERT BORDERLANDS IN HISTORICAL CONTEXT

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ABSTRACT.—Many types of foods are used when more preferred foodstuffs are unavailable, for example, during food shortages. Famine foods used by indigenous peoples of southwestern United States and northernmost Mexico, the Desert Borderlands, are enumerated. Through comparison with prehistoric dietary data, it is then argued that patterns of food preference in the study region changed within the past 400 years, since European contact, colonization, and domination. It is further suggested that myth and ritual are especially important vehicles for transmitting the knowledge of famine food use between generations, because this category of ethnobotanical knowledge is easily lost.

RESUMEN.—Muchos tipos de alimentos se emplean cuando los víveres preferidos no están disponibles, por ejemplo durante carestías. Se enumeran los alimentos de hambruna usados por los grupos indígenas del suroeste de los Estados Unidos de Norteamérica y el extremo norte de México, el área de frontera desértica. A través de la comparación con datos dietéticos prehistóricos, se argumenta a seguir que los patrones de preferencia alimentaria en la región estudiada han cambiado en los últimos 400 años, a raíz del contacto, colonización y dominación europea. Se sugiere además que el mito y el ritual son vehículos especialmente importantes para transmitir de generación en generación el conocimiento del uso de alimentos de hambruna, puesto que esta categoría de conocimiento etnobotánico se pierde facilmente.

RÉSUMÉ.—Les peuples emploient un grand nombre de sortes d'aliments quand les aliments préférés ne sont pas disponibles, par exemple, pendant les périodes de manque de vivres. Ici les auteurs énumèrent les aliments de famine employés par les peuples indigènes du sud-ouest des Etats-Unis et du Méxique du Nord extrême et des Terres-frontières désertiques. Par comparaison avec des data sur le régime de nourriture préhistorique, nous proposens que les modèles de préférences alimentaries dans la région étudiée se sont transformés pendant les 400 ans passés, dès le contact européen, la colonisation, et la domination. Nous suggérens de plus que les mythes et les rites sont des moyens specialement importants pour la transmission de la connaissance des aliments de famines entre les générations parce que cette catégorie de connaissance ethnobotanique est très facilement perdue.

Through want and hard hunger they gnaw at the dry and desolate ground, they pick mallow and the leaves of bushes. —JOB 30:3

INTRODUCTION

Not all foods are equal. Some are relished, others only tolerated, and still others are loathed, being eaten only when necessary. On occasion the Trobriand Islanders, for example, "have to fall back on the despised fruit of the *noku* tree, which is hardly edible but hardly ever fails" (Malinowski 1935:16). As should be the case, greatest scientific attention concentrates on the most common foods. Yet this emphasis should not blind us to the value of studying less desirable foods, often called "famine foods," "starvation foods," "emergency foods," or "queer foods" as so quaintly termed by Kagwa (1934).

Here, I briefly examine the ethnobotanical literature on famine food use by indigenous groups of the Desert Borderlands, emphasizing agriculturalists but also including information on other groups in the southwestern United States and northernmost Mexico. After reviewing general characteristics and importance of famine foods, specific examples from the Desert Borderlands are enumerated. Then I outline a historical process of change in food preference patterns under changing socio-political contexts and suggest that famine food use has changed dramatically through time since European contact. This illustrates that food preference patterns are clearly embedded within their social, economic, historical, and political contexts and are not simply a function of the biological character of these plants.

Characteristics of famine foods.—Famine foods must meet two minimal characteristics. First, they have to be edible, and second, they must be available even when more frequently consumed rations cannot be acquired. Famine foods can often barely claim the first and may require substantial processing to make them edible or to reduce their toxic constituents. The second characteristic is particularly interesting, because we might be able to predict what classes of resources will be famine foods based on their biological character and ecological requirements. Some of the most important famine foods should be those plants that are especially resistant to the factors which reduce yields of more preferred foods. When droughts are the primary factor reducing food procurement, then drought resistant plants should be important famine foods. Most likely these will be xerophytic plants, such as cacti, perennials, or plants growing in environments not affected by precipitation deficits. When predation is a primary limiting factor, plants with particularly effective biochemical or structural defenses against predation should be major famine foods.

Just as food shortages range from "hunger seasons" (e.g., Richards 1939; Annegers 1973; Ogbu 1973; Colson 1980) to massive famines, so too there are various types of low preference foods. First are foodstuffs consumed only during severe food shortages. In addition, traditional populations often endure seasonal periods of low food availability, and there are "seasonal hunger" foodstuffs eaten at these times. Another category of low preference foods are those that are normally consumed and whose use is intensified during periods when other foods are unavailable. An example of the latter group is mesquite fruits *(Prosopis glandulosa)* which are staples for some groups of the Desert Borderlands. During

times when crops fail, the collection of these plants simply may be increased. Century plant (mescal, *Agave)* and various cacti are other examples of widely and frequently consumed native food resources in the Desert Borderlands which also provide an unusually stable resource during food shortages. The Seri on the coast of Sonora, Mexico, present an example:

> During extended droughts ephemerals fail to appear, substantially fewer century plants are edible because they do not become reproductive, and many other major perennials have reduced production. Nevertheless, it appears that most Seri were able to locate edible plants at any time of the year. During extended drought on San Esteban Island, however, the only plant available was *Agave cerulata,* which is rich in carbohydrates but low in protein and lipids. (Felger and Moser 1985:95)

The status of a particular plant as a famine food is dependent upon many factors including its biological and biochemical constitution. Some low preference foods have toxic constituents which cause discomfort after eating, yield products of low nutritional value, are foul-tasting, or their consumption requires substantial processing to render them edible. Alamgir (1980:121) reports from Bangladesh that "starvation and the use of alternative 'famine foods' led to epidemics of diarrheal diseases in many areas." Similarly, Irvin (1952) mentions several examples of the deleterious effects due to the consumption of famine foods in the Sudan and other areas of Africa. Other biological factors determine whether a foodstuff might be used only as famine food. These can include low population densities, irregular production, or availability at the wrong time of the year.

Variables other than resource biology are important in understanding famine foods; cultural factors are, likewise, critical. Some low preference foods are tabooed to all or a portion of a population. Ritually tabooed foods, however, are known to be consumed during periods of starvation (e.g., Honigman 1954; Cerulli 1964), and it is quite likely that this practice is more frequent than reported. Seed stock saved for future planting is clearly a famine food of last resort for farmers because of the long-term consequences of this action. Plantain saplings, for example, are a famine food in parts of Bangladesh (Alamgir 1980) as were maize seed among the Hopi (Beaglehole 1937). Agricultural by-products also can be consumed. Of the six major classes of famine foods mentioned for one Bangladesh community, two are agricultural by-products, rice hulls and rice water, not normally eaten by humans (Alamgir 1980). Yue (1985:80–81) illustrates well the use of what would otherwise be crop by-products during a Chinese famine in 1959:

> The sent-down cadres organized a group to investigate other ways of obtaining nourishment, by crushing corncobs into powder, for example, and mixing this with a little corn flour to make buns . . . An even cruder kind of bun was made by mixing crushed rice husks and corncobs together with a small amount of ground corn. We also gathered apricot leaves, dried them in the sun, and ground them into flour, sometimes mixing this with powdered elm tree bark to make a porridge. It was a desperate time.

Some resources could be available in the territory of hostile groups, and thus the social cost of use may be quite high. Castetter et al. (1938), as an example, mention that in the past some Pima of the Sonoran desert would not collect the century plant in certain areas because of possible attacks by Apache. Another cultural factor is processing technology. Foods requiring unfamiliar preparation may be less preferred. Various relief rations to Ethiopia were at first not well-integrated into the local cuisine, because these foods were unfamiliar (Mason et al. 1974). Likewise, Woodham-Smith (1962) discusses how the importation of maize in the 1840s during the Irish Potato Famine created confusion, because it was a food unfamiliar to both peasants and administrators.

Finally and perhaps most importantly, the characterization of a food as low preference is, of course, logically dependent upon the availability of more preferred foods. Changes in the foods available, therefore, should change preference patterns. This factor is one overlooked in discussion of famine foods because such studies have tended to be ahistorical. With the introduction of new crops and edible wild foods between areas, the role of native foods can change. I attempt to demonstrate that such a change occurred in the Desert Borderlands during the past four centuries, since Spanish contact and conquest followed by governmental administration by Mexico and then the United States.

Famine foods: importance and frequency.—The study of low preference foods has theoretical and practical value. The use of famine foods seems to be a universal strategy for coping with severe food shortages; it is impossible to estimate how many lives have been spared by the use of these foods. Not only does the study of famine foods document a little known set of foods, but they have characteristics that might be exploitable. These plants survive and can produce food, however tenuous the claim of edibility may be, under extremely unfavorable conditions, and this characteristic may be manipulated in the development of new crops and economic products. It is quite likely that some of these plants could become cultigens if bred to reduce undesirable biochemical properties and other factors limiting use.

Because of infrequent use and lowest status, low preference foods seem to be underrecorded in ethnobotanical literature, even though many such foods surely exist. The use of famine foods is one of the most commonly recorded actions taken by peoples throughout the world to cope with food shortages, based on a cursory survey of the Human Relations Area File. Unfortunately, most of the examples are simply superficial and anecdotal references that rarely identify the famine foods adequately. One example from ancient China does, however, clearly demonstate the extensive use of famine foods, and I believe accurately reflects the diversity of famine foods. The *Chiu-Huang Pen-ts'ao* published in 1559 describes 414 plant famine foods used in Hunan province alone (Read 1946). Such a large number of famine foods from only one small region suggests that the number of famine foods throughout the world could be truly staggering. A large corpus of folk information on famine foods must reflect their critical importance to humanity. As Scudder (1962:211) states in regard to the Gwembe Tonga of central Africa:

> . . . while I believe that a number of these reports are overly optimistic about the ability of wild produce alone to support an agricultural population for extended periods of time without widespread malnutrition and starvation, it cannot be denied that time and again crop failure has led to intensive exploitation of the rich flora of the Valley.

There may be many reasons why the use of starvation foods seems to be reported so infrequently in ethnobotanical literature. Practices of traditional rural peoples who often form the lowest stratum of nation-states are frequently viewed negatively. And most likely the use of famine foods, which are barely edible, might be considered especially "primitive" and suffer a harsh judgement. Consequently, the use of these resources would not be widely acknowledged. Furthermore, with the increasing incorporation of traditional peoples into industrial, national, and international economies, the use of local famine foods surely has decreased as other strategies for coping with food shortages, such movement to urban areas or increasing use of international relief supplies, have gained importance. Combined with increased urbanization, these factors can lead to the substantial loss of information about foods useful during famines. The lack of this knowledge was so acute during severe food shortages in World War II that the Dutch government felt compelled to issue a publication describing emergency food plants locally available and methods for preparing them (Den Hartog 1981).

THE DESERT BORDERLANDS

Environments of the Desert Borderlands vary from the desert coasts, rich with marine resources, through the inland Mohave, Great Basin, Chihuahuan, and Sonoran deserts to the rugged mountains and plateaus of the major continental mountain masses of the Sierra Occidental in Mexico and the Rocky Mountains in the United States (Fig. 1). Deserts basins are low, from less than 305 m in elevation for the Sonoran Desert up to 1,525 m for the Chihuahuan, Great Basin, and Mohave deserts. Precipitation in the deserts is sparse, approximately 200–300 mm per year. Grasslands and desert scrub communities dominate the deserts with relatively lush riparian vegetation along the larger drainages. Low deserts have cool winters, whereas the upland deserts experience cold winters. Major mountain ranges rise up to 4,200 m with precipitation ranging from 305 mm to over 1,020 mm annually. Mountain vegetation is composed largely of conifer woodlands with oaks and coniferous forests at higher elevations. Within these major zones is a great diversity of biological communities that have been most recently described by Brown (1982).

The present natural environments of the Desert Borderlands have undergone significant changes even within the past several hundred years (e.g., Brown 1982; Hastings and Turner 1965; Wauer and Riskind 1977). Many of these changes can be attributed to anthropogenic factors. Severe grazing pressure, hydrological modification, urban development, industrial farming, use of water far beyond recharge rates, and suppression of natural fires, among other factors, have altered

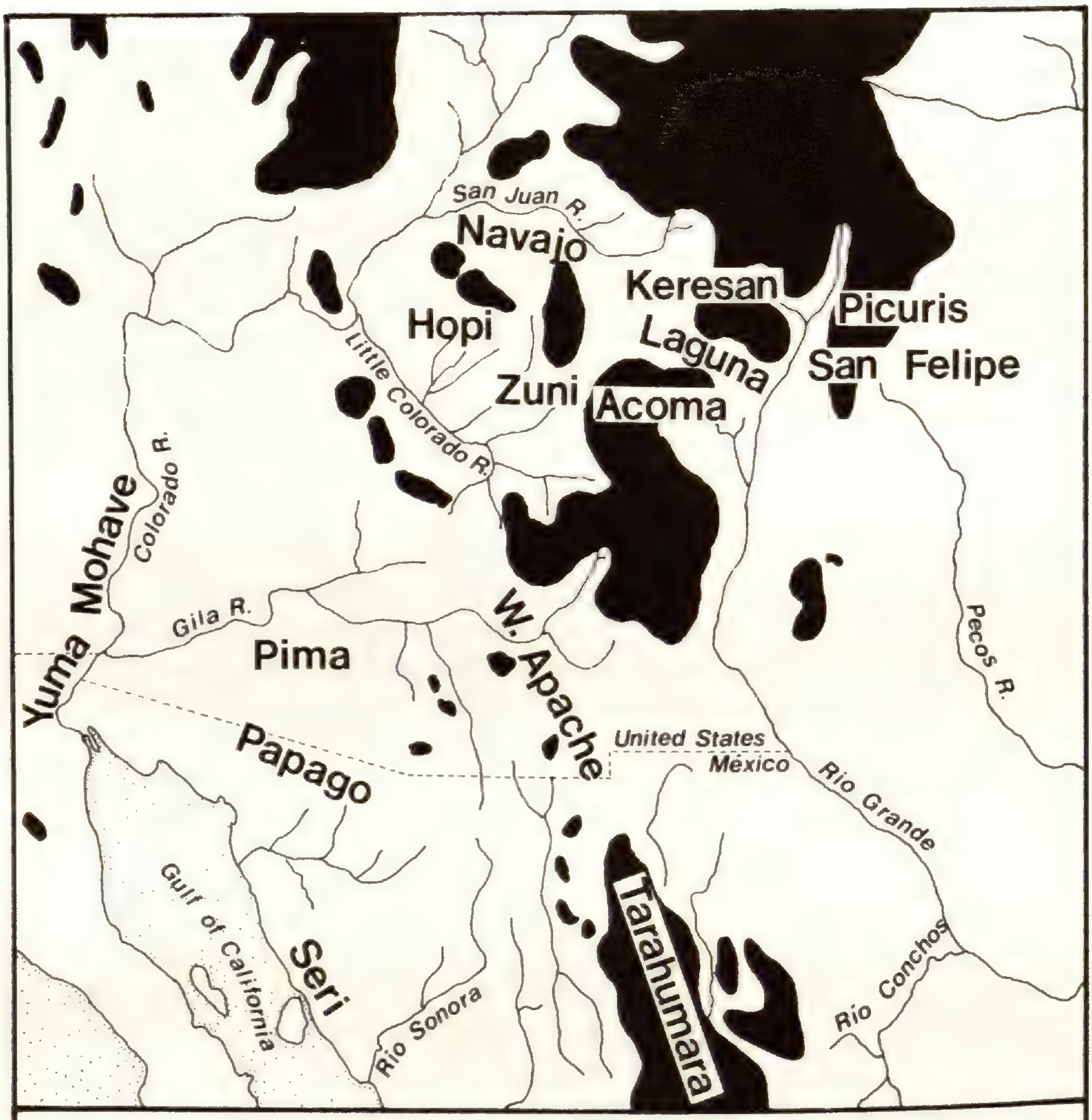

FIG. 1.—Map of the Desert Borderlands of the southwestern United States and northernmost Mexico showing the location of indigenous groups mentioned. The dark areas are major mountains, including the Rocky Mountains in the north, the Sierra Madre Occidental to the south, and the Mogollon highlands in the center of the map.

the environment, including the former distribution of native food plants. Bohrer (1975), for example, discusses the recent widespread reduction of cool-season grasses, whose seeds were once important foods for indigenous peoples.

The cultural environment of this region is, likewise, complex and ever changing; native populations have developed a rich suite of adaptations to the environmental and cultural conditons in the Desert Borderlands. Some groups have been mobile hunters and gatherers, whereas for at least 2000 years, others have been farmers, and more recently some have raised livestock.

The ethnographic present for groups considered here dates from the last century for most cultures to the present for others, such as the Seri. Famine foods have been recorded for the largely agricultural Puebloan groups of the Colorado Plateau and Rio Grande valley (Hopi, Zuni, Acoma, Laguna, San Felipe, San Juan, and Keresans). Agriculturalists of the Sonoran desert or Colorado River are also included (Pima, Mohave, Yuma), as are the Papago, a Sonoran desert group combining more hunting and gathering with agriculture. The Navajo and Ramah Navajo of the Colorado Plateau focus on herding and agriculture, whereas the Seri are hunter–gatherers of the desert coasts of Sonora, Mexico.

The political and economic impacts on native populations by Spanish, Mexican, and North American occupations have been profound and have not been the same for all populations in the Desert Borderlands. While many groups became extinct following European domination of the region, others partially maintained their cultural integrity to varying degrees. Even for those groups that have been marginally integrated into national economies, many changes have affected them. Traditional areas of economic exploitation have been significantly reduced, and new economic pursuits, such as animal husbandry, use of new crops, and sale of crafts, have been added to their economies. The Hopi, often cited as one of the more traditional cultures of the Desert Borderlands, now have a diet composed largely of nonlocal foods with little use of traditional resources (Kuhnlein and Calloway 1977).

Many environmental (e.g., fire, flood, pest infestation) and cultural factors (e.g., conflict, change in economic relationships) can reduce food availability. I believe, however, that one of the primary causes of food shortages in the Desert Borderlands has been unusually low precipitation. Paleoclimatic and historic records demonstrate periods of sustained and widespread droughts, both during prehistoric and historic times (e.g., Tuan et al. 1973; Sellers and Hill 1974; Dean and Robinson 1978; Euler et al. 1979; Dean et al. 1985; Hall 1985; Minnis 1985). Consequently, native populations in the Desert Borderlands have been familiar with food shortages for thousands of years and have developed a repertoire of strategies to cope with these threatening circumstances.

FAMINE FOODS OF THE DESERT BORDERLANDS

Although most references to Desert Borderlands ethnobotany and socio–ecology emphasize only the most commonly used plants, the voluminous ethnobotanical literature does provide mention of some famine foods, even though important characteristics of famine food are now unavailable. We have inadequate understanding of the chemical compositon of these resources, methods of preparation, who collects them, and precisely when and how these plants are used.

Table 1 lists probable famine foods recorded for the Desert Borderlands groups considered here. Not all plants listed are famine foods in the most restricted sense; also included are hunger season foods and those foods whose harvest is simply intensified under these conditions. The use of low preference foods is dynamic, yet few references provide sufficient documentation of their use. Therefore, the choice was made to include the widest number of possible famine foods in Table 1.

For sake of discussion, I divide Desert Borderlands starvation foods into seven categories, inner bark, cacti, agave and agave-like plants, other perennials, underground structures, annuals, and other. These categories mirror no indigenous folk classification, but plants within each category share some similarities. Resources availability in the first five groups should be quite stable; their availability is least affected by common environmental fluctuations in the Desert Borderlands. Abundance of food stuffs derived from plants in the sixth category, annuals, in contrast, may well be less stable, and they are, therefore, especially interesting.

TABLE 1.—Famine foods of the desert borderlands.

Plant (common name)	Part Consumed	Group— Comments	Reference
Inner Bark			
Juniperus monosperma (Engelm.) Sarg. (one-seeded juniper)	inner bark	Navajo & others Navajo	Castetter 1935 Elmore 1944
Pinus edulis Engelm. (pinyon)	inner bark	Ramah Navajo	Vestal 1952
Pinus ponderosa Laws. var. *scopulorum* Engelm. *(Pinus scopulorum)* (western yellow pine)	inner bark	Zuni Pueblo & others	Castetter 1935
Populus tremuloides Michx. (aspen)	inner bark	Ramah Navajo	Vestal 1952
Cacti			
Carnegiea gigantea (Engelm.) Britt. & Rose (saguaro)	fruit	Papago	Castetter & Bell 1942
		Seri—possible famine food	Felger & Moser 1974, 1985
Ferocactus wislizensi (Engelm.) Britt. & Rose (barrel cactus)	stem pulp	Seri	Felger & Moser 1976, 1985
Opuntia sp.	stem	Hopi Pueblos	Hough 1897
Opuntia clavata Engelm. (cholla)	stem (?)	Laguna & Acoma Pueblos	Swank 1932

Plant (common name)	Part Consumed	Group—Comments	Reference
Opuntia imbricata Haw. *O. arborescence)* (cane cactus)	stem	Laguna & Acoma Pueblos	Swank 1932
Opuntia polyacantha Haw. (prickly pear)	stem	Hopi Pueblos	Whiting 1939
Opuntia whipplei Engelm. & Bigel. (whipple cholla)	fruit	Hopi Pueblos	Whiting 1939
Pachycereus pringlei (S. Wats.) Britt. & Horak *(cardón)*	fruit	Seri—possible famine food	Felger & Moser 1974, 1985
Stenocereus alomoensis (Coult.) Gibs. & Horak *(pitaya agria)*	fruit	Seri—possible famine food	Felger & Moser 1974, 1985
Stenocereus thurberi (Engelm.) Buxb. (organ pipe cactus, *pitaya dulce)*	fruit	Seri—possible famine food	Felger & Moser 1974, 1985
Century Plant and Related Plants			
Agave sp. (century plants)	heart of plant (?)	Mohave & Yuma	Castetter et al. 1938
Agave cerulata spp. *dentiens* (Terl.) Gentry (century plant)	liquid from charred leaves	Seri	Felger & Moser 1970, 1985
Agave parryi Engelm. (century plant)	heart of plant	Pima	Castetter 1935
Dasylirion wheeleri Wats. (sotol)	heart of plant	—	Castetter 1935
Yucca spp.	heart of plant	"Pueblo Indians of New Mexico"	Castetter 1935
Yucca glauca Nutt. (yucca)	heart of plant	Laguna & Acoma Pueblos	Swank 1932
Other Perennials			
Acacia pennatula (palo garabo)	fruit and seeds	"Mexico"	Altschul 1973
Amaranthus sp. (pigweed)	—	Ramah Navajo—used ceremonially and during food shortages	Vestal 1952
Apodanthera undulata Gray	fruit	Pima Bajo	Pennington 1980

TABLE 1.—Famine foods of the desert borderlands. (continued)

Plant (common name)	Part Consumed	Group—Comments	Reference
Atriplex lentiformis (Torr.) Wats. (quail bush)	seeds	Pima	Curtin 1949
Atriplex polycarpa (Torr.) Wats. (all scale)	seed	Pima	Curtin 1949
Baccharis salicifolia (R&P) Pers. *(Baccharis glutinosa* Pers.) (seepwillow)	greens	Mohave & Yumans	Castetter & Bell 1951
Juniperus monosperma (Engelm.) Sarg. (one-seeded juniper)	fruit	Hopi Pueblos Laguna & Acoma Pueblo	Whiting 1939 Swank 1982
Lycium pallidum Miers. (wolfberry)	fruit	Hopi Pueblos	Whiting 1939
Oryzopsis hymenoides (R&S) Ricker *(Eriocoma cuspidata)* (Indian ricegrass)	grains	Hopi Pueblos	Castetter 1935
Phoradendron juniperinum Engelm. (mistletoe)	fruit	Lagnua & Acoma Pueblos	Swank 1932
Prosopis glandulosa Torr. (mesquite)	fruit and seed	Pima Hopi Pueblos (?) Yuma	Bell & Castetter 1937 Bell & Castetter 1937 Bell & Castetter 1937
Prosopis glandulosa Torr. var. *torreyana* (L. Bens.) M.C. Johnst. (western honey mesquite)	fruit	Seri—possible famine food	Felger & Moser 1971, 1985
Prosopis pubescens Benth. (screwbean)	fruit	Pima & Papago (?) Yuma Seri	Bell & Castetter 1937 Bell & Castetter 1937 Felger & Moser 1971, 1985
Quercus grisea Liebm. (gray oak)	fruit	Ramah Navajo—"not good food"	Vestal 1952
Quercus undulata Torr. (wavyleaf oak)	fruit	Ramah Navajo—"not good food"	Vestal 1952
Rhizophora mangle L. (mangrove)	fruit	Seri	Felger & Moser 1976, 1985
Ribes inebrians Lindl. (squaw currant)	fruit	Hopi Pueblos	Whiting 1939
Rosa arizonica Rydb. (rose)	fruit	Hopi Pueblos	Whiting 1939
Simmondsia chinensis (Link) Schneid. (jojoba)	nut	Seri	Felger & Moser 1976, 1985

Plant (common name)	Part Consumed	Group—Comments	Reference
Underground Structures			
Dichelostemma pulchellum (Salisb.) Heller var. *pauciflorum* (Torr.) Hoover (*Brodiaea capitata* var. *pauciflora*) (bluedick, incorrectly cited as "Papago blue bells")	tuber	Papago	Castetter & Bell 1942 Castetter & Underhill 1935
Habenaria sparsiflora Wats. (bog orchid)	bulb	San Felipe Pueblo	Castetter 1935
Solanum fendleri Cav. (nightshade)	tuber	Keresan Pueblos—raw/boiled with clay	White 1944
Solanum jamesii Torr. (wild potato)	tuber	Keresan Pueblos—same as for *S. fendleri*	White 1944
Sphaeralcea coccinea Pursh. (globemallow)	root	Navajo	Elmore 1944
Annuals			
Acanthochiton wrightii Torr.	greens	Hopi Pueblos	Hough 1897; Castetter 1935; Whiting 1939
Aster spinosus Benth. (spiny aster)	greens	Mohave & Yumans	Castetter & Bell 1951
Chamaesaracha coronopus (Dunal) Gray (small groundcherry)	fruit	Hopi Pueblos	Whiting 1939
Chenopodium sp. (goosefoot)	seed	Ramah Navajo—used ceremonially and during food shortages	Vestal 1952
Cleome serrulata Pursh. (Rocky Mountain beeweed)	greens	Ramah Navajo—used ceremonially and during food shortages	Vestal 1952
	greens	Picuris Pueblo (?)	Krenetsky 1964
	seeds	New Mexican Hispanics	Curtin 1965
Dicoria brandegei Gray	flower/fruit	Hopi Pueblos	Whiting 1939
Mentzelia pumila (Nutt.) T&G (blazing star)	seed	Hopi Pueblos	Whiting 1939
Mentzelia multiflora (Nutt.) Gray (blazing star)	seed	Hopi Pueblos	Whiting 1939

TABLE 1.—Famine foods of the desert borderlands. (continued)

Plant (common name)	Part Consumed	Group—Comments	Reference
Physalis hederaeofolia (Gray) var. *cordifolia* (Gray) *(Physalis fendleri* Gray) (groundcherry)	fruit	Hopi Pueblos	Whiting 1939
Solanum triflorum Nutt. (nightshade)	fruit	Acoma & Laguna Pueblos	Castetter 1935
Sonchus asper L. (spiny sow thistle)	greens	Mohave & Yumans	Castetter & Bell 1951
Sysymbrium irio L. (London rocket)	greens	Mohave & Yumans	Castetter & Bell 1951
Thelypodium integrifolium (Nutt.) Endl. *(Thelypodium liliacinum* Green)	greens	Mohave & Yumans	Castetter & Bell 1951
Other			
Washingtonia filifera Wendl. (desert palm)	stem pith	—	Cornett 1987
Zostera marina L. (eelgrass)	seed	Seri	Felger & Moser 1973, 1976, 1985
"grasses/pigweed/goose-foot" (see *Amaranthus & Chenopodium)*	seed	Ramah Navajo—used ceremonially and during food shortages	Vestal 1952
cactus/wild potato/grass	?	Hopi Pueblos	Beaglehole 1937

Nomenclature follows Benson 1969; Felger and Moser 1985; Gentry 1982; Lehr 1978; Martin and Hutchins 1980. Non-technical terms are used to describe for plant anatomy (for example, an achene is termed a "seed"). Scientific names in parenthesis are those used in the original citation. Plants listed here include food used only during food shortages, foods used during seasonal shortages, as well as those normally consumed and whose use is simply intensified with low food availability. In the absence of detailed descriptions of the use of possible Desert Borderland famine foods, I decided to include the widest possible range of these resources.

Inner bark.—A widely recorded category of starvation food in the Desert Borderlands is the inner bark (cambium and associated tissue) of various trees; inner bark is not recorded as a "normal" ration (e.g., Swetnam 1984). There is ethnographic documentation of inner bark use of the pinyon pine *(Pinus edulis),* one-seeded juniper *(Juniperus monosperma),* western yellow pine *(Pinus ponderosa* var. *scopulorum),* and aspen *(Populus tremuloides).* This mucilaginous food is widely available and is abundant throughout the forests of the Desert Borderlands.

More importantly, it is a very stable resource. Environmental variation which reduces the availability of edible flowers, fruits, and seeds would be less likely to affect adversely the abundance of viable inner bark. Perhaps the factor limiting normal use of this resource is its probable low nutritional value and the considerable effort required to harvest sufficient quantities. Furthermore, sustained harvest of inner bark might seriously reduce tree populations.

Why is the inner bark of only certain plants utilized as famine food? Hundreds of different woody plants are present in the Desert Borderlands, yet the ethnobotanical record lists very few plants with edible inner bark. Many of the plants recorded to have edible inner bark are conifers which have easily removable bark. This alone cannot explain the pattern of use, however, because there are numerous conifers not cited as yielding edible inner bark.

Cacti.—Native peoples throughout the Desert Borderlands have long used cactus fruits as food. Saguaro fruits *(Carnegiea gigantea)* have been a major food for groups living within its range. The Seri use the fruits of several columnar cacti. The stems, joints, and pads of cacti, such as *Opuntia* (prickly pears and cholla), have been widely used by some groups throughout the Desert Borderlands.

The use of cacti as a famine food is well documented for indigenous peoples in the Desert Borderlands. By their nature, cacti are well adapted for survival and reproduction during periods of severe drought, a primary cause of crop failure. According to Felger and Moser (1974, 1985), the exploitation of varous cacti, such as saguaro, *cardōn (Pachycereus pringlei), pitaya agria (Stenocereus alomoensis),* and *pitaya dulce* or organ pipe cactus *(Stenocereus thurberi),* is increased during droughts, and the Seri also use the pulpy "stem" of the barrel cactus *(Ferocactus wislizeni)* as a famine food. Other cacti are also recorded as famine foods. The Pueblo Indians of Acoma, Laguna, and Hopi use various species of *Opuntia,* both cholla and prickly pear, during food shortages.

Century plant and related plants.—The century plant *(Agave)* and agave-like plants *(Yucca, Nolina,* and *Dasylirion)* are important foods for many groups in the Desert Borderlands and seem to have been prominent famine foods. These plants are perennial, can store enormous amounts of tissue, and can survive severe droughts. As cited earlier, at least one group of Seri rely on *Agave cerulata* when other foods are unavailable. The Pima, Mohave, and Yuma are recorded to have used the century plant (including *A. parryi)* as a starvation food. The stem of *Yucca glauca* is reported as a famine food at Acoma and Laguna. Sotol *(Dasylirion wheeleri)* is a famine food, although the group using sotol in this manner is not specified.

Other perennials.—We would expect many famine foods would be the reproductive structures of perennials, because some of them would be especially resistant to the effects of low moisture periods. The fruits of the one-seeded juniper *(Juniperus monosperma)* are a famine food for the Hopi, Laguna, and Acoma Indians. The bitter fruit of coyote melon *(Apodanthera undulata)* is a famine food among the Pima Bajo of central Sonora. The fleshy berries of the wolfberry *(Lycium pallidum),* squaw currant *(Ribes inebrians),* and the dry fruits of a native rose *(Rosa arizonica)* are Hopi famine foods. Fruits of a mistletoe *(Phoradendron juniperum),*

a parasite on conifers, are a famine food for the Puebloans of Acoma and Laguna. Mesquite *(Prosopis glandulosa)* and screwbean *(Prosopis pubescens)* are recorded as a possible famine food for the Pima, Papago, Yuma, Seri, and Hopi. Mesquite and screwbean seeds are often used as famine foods, whereas the mesocarp of the pods is the preferred food. Acorns *(Quercus grisea, Q. undulata)* may have been famine foods for the Ramah Navajo, a group living east of Zuni Pueblo. A note on a herbarium specimen from Mexico collected by H.S. Gentry noted that the fruits (with enclosed seeds) of *Acacia pennatula* were used as a famine food in Mexico. Mangrove *(Rhizophora mangle)* and jojoba *(Simmondsia chinensis)* fruits are consumed by the Seri when more preferred foods are unavailable. The seeds of several saltbushes *(Atriplex lentiformis and A. polycarpa)* are recorded as famine foods among the Pima.

Many grasses are present in the Desert Borderlands, and they are important foods. Yet there are only a few references to unspecified grasses as famine foods, and only one specific grass, Indian ricegrass *(Oryzopsis hymenoides),* is listed as a famine food. This perennial has several characteristics that make it a particularly valuable food for humans. It was once present in dense stands, it matures early, has a relatively high protein content, and the seeds tend to remain on the plant longer than in many grasses. Its use as a famine food is enhanced by notable drought tolerance (Hanson 1972; Quinones 1981).

"Greens" (probably leaves or young stems) of only one perennial tree or shrub, seepwillow *(Baccharis salicifolia),* is recorded as a famine food for the Desert Borderlands. This is of interest in light of the numerous foodstuffs in other areas of the world which are derived from tree or shrub leaves. As a comparison, over half of the foods listed in the *Chiu Huang Pen-ts'ao* are leaves, and many are from woody plants (Read 1946).

Underground structures.—Another category of unusually stable resources used as famine foods is "tubers" and roots. The availability of these resources should be quite stable. Wild potato *(Solanum jamesii, S. fendleri)* tubers are famine foods for Puebloan groups of New Mexico. To counteract their naturally bitter taste, salty clay is added to the mashed tubers. People of San Felipe Pueblo are documented to have used the "bulb" of *Habenaria sparsiflora* as a famine food. Globemallow *(Sphaeralcea coccinea)* roots are a Navajo famine food. Bluedick bulbs *(Dichelostemma pulchellum* var. *pauciflorum),* incorrectly identified by Castetter and Bell (1942) as Papago blue bells, are a famine food for the Papago.

Annuals.—The sixth group of famine foods, annuals, is especially interesting because foodstuffs derived from these plants should be more susceptible to drought conditions, a primary cause of food shortages in the region. Many annuals simply fail to germinate during low moisture conditions. Consequently, we could expect them to be relatively unimportant famine foods. However, numerous annuals are listed as famine foods. The Hopi are reported to use immature *Acanthochiton wrightii* as greens, and Rocky Mountain beeweed *(Cleome serrulata)* is consumed in a similar manner by the Ramah Navajo. Greens of other plants *(Aster spinosus, Sonchus asper, Sysymbrium irio,* and *Thelypodium integrifolium)* are famine foods among the Mohave and Yuman groups, although the middle

two are Euro–Asian weeds introduced in the region since European contact. Hispanics of northern New Mexico use Rocky Mountain beeweed seeds as a famine food. Hopi famine foods also include the fruits of the groundcherry *(Physalis hederaeofolia* var. *cordifolia)* and small groundcherry *(Chamaesartha coronopus).* The fruits of a nightshade *(Solanum trifolium)* are a famine food at Acoma and Laguna. The small dry "seeds" of pigweed *(Amaranthus),* goosefoot *(Chenopodium),* and blazing star *(Mentzelia pumila, M. multiflora)* are eaten by the Hopi when other foods are unavailable. The seeds and flowers of another annual, *Dicoria brandegei,* are famine foods for the Hopi.

As will be discussed later in more detail, the greater than expected number of annuals listed as famine foods might be due to a historical change in famine food classification, where plants once used as hunger season foods became today's famine foods.

Others.—Two plants recorded as famine foods do not neatly fit into the above categories. Eelgrass *(Zostera marina),* a marine plant, is extensively used by the Seri and may have been a famine food. Needless to say, this aquatic plant is not as affected by low precipitation as are terrestrial plants. The pith of the desert fan palm *(Washingtonia filifera)* is used as a famine food. In many ways, this resource is analogous to the hearts of the century plant, although its nutritional composition may be quite different.

DISCUSSION

The use of famine foods is a complex phenomenon involving a multitude of both biological and cultural factors. Simple enumeration of available famine foods, a worthy goal itself, does not, however, allow us to appreciate the dynamic nature of their use. Here I will discuss various aspects critical for an understanding of famine food use. First discussed is the historical change in famine food use, and I will argue that food preference patterns may actually encapsulate the history of changing diet. Therefore, patterns of famine food usage makes little sense without a historical perspective. Second is a consideration of how human populations transmit knowledge of famine foods to a new generation. How is knowledge of infrequently used resources maintained in a community, especially if use of famine foods occurs less than once per generation? I suggest that ritual and myth are unusually important in maintaining knowledge famine foods within a community. Thirdly, it is suggested that use of famine foods may be an indicator of the severity of food shortages. Finally, the value of a cross–cultural and comparative perspective on famine foods is briefly considered.

Historic change in famine food use.—In light of the hundreds of useful plants recorded in the ethnobotanical literature of the Desert Borderlands, relatively few famine foods are discussed. Undoubtedly, there are many unreported resources which have been used as famine foods by the indigenous populations in the region, and it is quite likely that much of the inventory of traditional famine foods has been lost since European contact and before intensive ethnographic documentation began around 100 years ago.

I suspect an additional dimension is also an important reason for the few famine foods recorded. By the time ethnographers recorded the ethnobotany of most native peoples in the area, many of these peoples had dramatically altered their subsistence base. Such changes included the introduction of new crops, new agricultural technology, animal husbandry, increased sedentism, and substantial involvement in market economies. I argue that traditionally important foods had been relegated to less frequent use. Some of these plants then became potential famine foods. In short, the introduction of a new set of resources caused a resorting of general food preference patterns with some newly acquired plants replacing some former foods and these in turn becoming less commonly used. Previous famine foods were then replaced by what were once more common foods. And the knowledge of the ''original'' famine foods may have been completely lost. Specifically, many of the famine foods recorded for modern groups in the Desert Borderlands may well have been seasonal hunger foods.

If this scenario is correct, then it provides an explanation for the unexpectedly large number of annuals now considered famine foods. If periods of low precipitation were the major cause of food shortages, as I believe, then one needs to understand why so many annuals are now viewed as famine foods. After all, annuals presumably would be one of the first groups of plants adversely affected by insufficient moisture. Drought resistance, however, would not necessarily be a characteristic important for hunger season plants. A shift of hunger season plants to famine foods could account for a large number of annuals being considered famine foods.

Prehistoric diet provides a needed comparative baseline to document change in famine food use through time, because it can be difficult to estimate how frequently these current famine foods were used by the prehistoric peoples of the Desert Borderlands. Many of the plants listed ethnographically as famine food seem to have been more common food plants before European contact. Grass (e.g., *Oryzopsis hymenoides),* pigweed *(Amaranthus* spp.), and goosefoot *(Chenopodium* spp.) seeds, for example, are now considered famine foods and are common prehistoric food remains found in archaeological sites in the Desert Borderlands (e.g., Adams 1980; Minnis 1985; Wetterstrom 1986).

Perhaps the best paleodietary data to evaluate a model of changing food preference come from prehistoric feces, because these data are the direct remains of consumed food. The most extensive coprolite data come from cliff dwellings in a northern portion of the region, the Four Corners area of the United States. These dessicated fecal remains are from the prehistoric Anasazi tradition, one of many prehistoric populations ancestral to modern Puebloan groups. The fecal content information can be used as a controlled comparison between ethnographically documented famine food use by the Hopi, a modern Pueblo group in the Four Corners area, and an ancestral prehistoric Puebloan diet in the same region.

A recent summary of paleofeces shows that many plants now recorded as famine foods are some of the most frequent native plants found in these coprolites (Minnis 1989). Of particular interest for the purposes of this study are 139 paleofeces from the latest prehistoric time period, Pueblo III, A.D. 1100–1300, the time just before European contact and with the best paleodietary data.

Coprolites considered here were recovered from three sites in or near Mesa Verde, southwestern Colorado, (Step House, n=17; Lion House, n=4; Hoy House, n=56), Glen Canyon, southeastern Utah, (n=24), and two sites in northeastern Arizona (Inscription House, n=16; Antelope House, n=22). Macroscopic plant remains, mostly seeds and fruit fragments but also some tissue, were identified in the feces. Most of the analyses summarized in the study simply noted presence/absence of a taxon in each specimen and did not attempt to quantify the amount of each resource in each coprolite.

Cultivated plants, especially maize and squash, were the most commonly consumed foodstuffs, being found in the vast majority of the coprolites studied (Table 2). Of the natural flora, the most common remains from these feces are, in descending frequency: prickly pear, goosefoot, groundcherry, purslane (*Portulaca* sp.), pigweed, ricegrass, grass seeds, cactus, peppergrass (*Lepidium* sp.), pinyon, and Rocky Mountain beeweed. Other plants were identified as very infrequent constituents in these feces, often being found in only a single coprolite.

There is a surprisingly close correspondence between important native foods consumed by the prehistoric peoples of the northern part of the Desert Borderlands and foods ethnographically classified as famine foods within the past century, especially among the Hopi. Whiting (1939:20–22) lists Hopi famine foods: wolfberry (*Lycium pallidum*), cholla (*Opuntia whipplei*), prickly pear (*O. polyacantha*), squaw current (*Ribes inebrians*), wild rose (*Rosa arizonica*), groundcherry (*Physalis fendleri*), Indian ricegrass (*Oryzopsis hymenoides*), and blazing star (*Mentzelia pumila, M. multiflora*). Prickly pear, goosefoot, groundcherry, pigweed, ricegrass, grass seeds, and the general category "cactus" are all documented in Table 1 as famine foods and are common prehistoric dietary items (Table 2).

The fact that many of the most frequently consumed prehistoric foods are now classified as famine foods can be explained in one of two ways. First, it can be argued that remains in these coprolites reflect the use of prehistoric famine foods. That is, the paleofeces document serious food provisioning problems. There are two reasons why I believe that this explanation is faulty. First and most importantly, maize is by far the most abundant foodstuff in these coprolites. Maize was found in nearly 90% of the coprolites, and where data are available it often comprises the bulk of feces (Minnis 1989). In contrast, the most common native plant (prickly pear) was noted in approimately 30% of the paleofeces. Maize cultivation, and ultimately yield, are more sensitive to drought than many native foods. Consequently, we would expect some reduction in maize consumption under drought conditions. It is unlikely that maize would be as common as it is in the feces if they are a record of famine food use. Second, the coprolite assemblages represent a time of expanding prehistoric populations and substantial construction of villages in the Four Corners area. If food shortages were so frequent, then it would be unlikely that the prehistoric cultures would have been as expansive.

The second possible explanation is, to my mind, more likely. Many of these resources, which are now famine foods, were basic constituents of the prehistoric diet in the area. Viewed in this light, there seems to have been a shift of resource use along a scale of preference. Robbins et al. (1916:76), for example, obliquely narrate this shift for the Tewa of San Juan Pueblo:

TABLE 2.—Plants from prehistoric Four Corners coprolites[1]

Plant[2]	Rank	Percentage of Coprolites containing Plant
Zea mays	1	87.8
Opuntia (prickly pear)	2	28.1
Cucurbita	3	25.9
Chenopodium	4	19.5
Gossypium hirsutum	5.5	16.6
Physalis	5.5	16.6
Portulaca	7	14.4
Phaseolus	8	13.7
Amaranthus	9	12.3
Oryzopsis hymenoides	10	11.5
Gramineae	11	10.8
Cactaceae	12.5	10.1
Lepidium	12.5	10.0
Pinus edulis	14	9.9
Cleome serrulata	15	7.9

[1]The data base is 139 paleofeces from six sites dating to the Pueblo III period, A.D. 1100–1300. For an in-depth discussion of this study, consult Minnis (1989).

[2]These are the most frequently encountered plant taxa. Less commonly recovered types are: buffaloberry *(Shepardia argentea)*, bugseed *(Corispermum)*, bulrush *(Scirpus)*, chokecherry *(Prunus virginiana)*, sunflower family (Compositae), dropseed *(Sporobolus)*, *Cryptantha* sp., hackberry *(Celtis occidentalis)*, horsetail *(Equisetum)*, juniper *(Juniperis osteosperma)*, knotweed *(Polygonum)*, bean family (Leguminosae), Mormon tea *(Ephedra)*, panicgrass *(Panicum)*, sagebrush *(Artemesia tridentata)*, saltbrush *(Atriplex canescens)*, skunkbush *(Rhus trilobata)*, sunflower *(Helianthus)*, and wild buckwheat *(Erigonum)*.

> But nowadays, although wild berries and nuts are still gathered in autumn and green weeds are eagerly sought and eaten in the spring, there is a very general and increasing neglect of all but *the most common and best-liked*. Formerly it was a matter of necessity that the housewife should know them and store them; for although in normal years they were merely a pleasant addition to the diet, yet in drought, flood, fire, or a hostile raid might destroy the crops at any time, thus making the wild products an indispensable resource (emphasis added).

It is quite possible that the knowledge of foods traditionally used only during severe famines has been lost and that foods now recorded as famine foods

are those that were consumed during periods of seasonal hunger, usually the late winter and early spring when stores are depleted early in the new growing season (Richard I. Ford, personal communication, 1988). Since hunger seasons are quite common, use of these less preferred foods should be known by many individuals. Therefore, knowledge of these foods would have been less likely to have been lost than knowledge of foods used during infrequent severe shortages.

If plants that were frequently consumed become famine foods and knowledge of previous famine foods is lost, then the stability of starvation foods may also have changed. There is no reason to assume a priori that a new set of famine foods will be as resistant to the factors which reduce food availability as the previous famine foods. Thus, stability of the food supply in the face of environmental perturbations may have been reduced. I doubt that is a problem for the perennials such as inner bark, cholla, prickly pear, mesquite, and century plant. This cannot be said for the many annuals listed in Table 1, including plants such as pigweed, goosefoot, groundcherry, blazing star, and various grasses. It may well be that the presumed change in famine foods of the Desert Borderlands has resulted in a less secure strategy should the circumstances necessitate the use of least preferred foods.

Native populations in the United States and Mexico are now relatively well buffered against famine by their participation in national economies with various economic security programs. Populations in other areas may have lost the knowledge of traditional famine foods during colonial disruption of their lifestyles. In other areas of the world which have experienced substantial changes in their native subsistence practices and with less well-developed economic security programs, groups could face specially severe problems with modern food shortages after losing the knowledge of traditional famine foods.

Unfortunately, we do not have as excellent a data base as the Anasazi paleofecal inventory to assess the extent of change in famine foods for other areas of the Desert Borderlands. While it has been cogently argued that maize was the focal foodstuff for many prehistoric groups in other areas of the Desert Borderlands, the biotic communities are much different from the Four Corners. To the south, there was a great diversity and abundance of high quality foods, including various leguminous trees (e.g., mesquite, ironwood, and palo verdes), many cacti, and a wide range of agavaceous and agave-like resources (e.g., century plant, sotol, yucca, and beargrass) (Gasser 1981). In addition, recent research has identified a suite of crops present in the low deserts not documented or uncommon in the northern portions of the Desert Borderlands. Minimally, these include a barley, *Hordeum pusillum* Nutt. (Adams 1986); century plant, *Agave murpheyi* F. Gibson or *A. parryi* Engelm. (Fish et al. 1985); tepary bean, *Phaseolus acutifolius* Gray var. *latifolius* Freem. (Nabhan and Felger 1984); scarlet runner bean, *Phaseolus coccineus* L. (Ford 1981; Huckell 1986); panic grass, *Panicum sonorum* Beal. (Nabhan and de Wet 1984); and devil's claw, *Proboscidea parviflora* (Woot.) Woot. & Standl. spp. *parviflora* var. *hohokamiana* Bretting (Nabhan et al. 1981; Bretting 1982). Therefore, the example of changes in diet as discussed for the Four Corners cannot be directly extrapolated to other regions. While the individual resources may be different, the process of change, that of the replacement of an assemblage of famine food by once more common resources, may well have occurred.

Learning famine food use.—The transmittal of famine food use between generations may provide a further understanding of how this shift occurred. Not only does this topic address ethnobotanical information transfer, but it may help explain how this information is lost. Desert Borderlands data are largely silent on this issue, but research from other areas provides some illumination. Presumably, children learn food availability, distribution, collection, and processing by watching and participating in normal adult activities. Beaglehole (1937) describes one informant's recollection of the actions taken by the Hopi in response to a famine which occurred during his childhood. The simple observation of behavior is effective for learning about common foods, including foods used during yearly hunger seasons, but could well be ineffective for the use of infrequently used foods, if these severe shortages are less frequent than once per generation. If so, then other mechanisms of learning may be particularly important for famine food use.

As many have pointed out, myths, legend, rituals, and stories about previous food shortages are critical for transmitting knowledge of famine food use (e.g., Roys 1967; Reining 1970; Cove 1978; Galt and Galt 1978; Colson 1980; Marcus 1982). Thus oral tradition may be especially important in perpetuating knowledge of famine food use. Special attention should focus on women's knowledge, because they seem to have the greatest familiarity with famine foods (Ali 1984). Yet, the role of male secular and ritual knowledge of plant foods cannot be ignored as will be seen in the forthcoming Zuni example.

Several Desert Borderland examples do illustrate the perpetuation of native plant food use through ritual. Vestal (1952) mentions that several Ramah Navajo famine foods are also used ritually, although he does not provide specific information. Two examples from Zuni, however, do mention famine foods in myths or in a ritual context. Bunzel (1932:714) provides a translation of "Sayataca's night chant." In this prayer, a range of edible plants is enumerated after mention of cultigens:

> . . . and then the seeds of the pinon tree, the seeds of the juniper tree, the seeds of the oak tree, the seeds of the peach tree, the seeds of the black wood shrub, the seeds of the first flowering shrub, the seeds of the *kapuli* shrub, the seeds of the large yucca, the seeds of the branched yucca, the seeds of the brown cactus, the seeds of the small cactus, and then also the seeds of the wild grasses—the evil smelling weeds, the little grass, *tecukta, kucutsi, o'co, apitalu, sutoka, mololoka, piculiya,* small *piculiya, hamato, mitaliko,* and then also the seeds of those that stand in their doorways, namely the cat–tail, the tall flags, the water weeds, the water cress, the round–leafed weed . . .

Richard Ford (personal communication, 1988), who conducts ethnobotanical research with the Zuni, points out that seeds of these native edible plants are a part of some Zuni ritual paraphernalia. Thus these plants must be collected each year, and this maintains the knowledge of the use of native plants and collection location of various foodstuffs which might otherwise be ignored. Cushing (1920:76) provides another example, the narration of a Zuni tale which mentions a time of famine and the collection of famine foods:

> At last despair filled the hearts of the people of Ha'-wi-k'uh. They went forth on the mesas to gather cactus fruit but even this was scarce. When winter came the cloud swallower had gone. The god of the ice caves breathed over the whole country, and even in the Valley of the Hot Water great banks of snow fell, such as the oldest men had never seen. At last the corn was all gone. The people were pitiably poor. They were so weak that they could not hunt through the snow, therefore a great famine spread through the village. At last the people were compelled to gather old bones and grind them for meal, and for meat they toasted the rawhide soles of their moccasins.

Once a group's oral traditions are disrupted, it is very unlikely that future generations will retain knowledge of low preference foods. This problem is especially acute if famine food use is so infrequent that normal participant observation in food use is ineffective in passing this information on to future generatons. If so, then plants used during hunger seasons might indeed become the only category of famine food knowledge passed on to future generations as alternative foods. An understanding of the dynamic nature of uses of plants mentioned in oral tradition is especially critical.

Famine food use as a monitor of shortage severity.—Use of famine foods may be a sensitive measure of the severity of food shortages. There are many actions people take when faced with food shortages. Such coping strategies include selling valuables, migration, stealing, change in agricultural strategies, cannibalism, raiding, and reduced or expanded cooperation within and between groups. Elsewhere I have argued that people faced with food provisioning problems choose strategies in a predictable sequence (Minnis 1985). Specifically, the least costly coping strategies tend to be used first (defining cost in cultural and social as well as economic terms). With increasing severity, more costly options will then be used. In other words, there is a "calculus" of human social and economic responses to food shortages. If so, the use of famine foods, as one such strategy, could be used to determine the severity of the shortage. Others have also suggested that the use of alternative foods, such as famine foods, may be a marker that a population is experiencing problems in food acquisition, even though signs of starvation and malnutrition may yet be lacking (e.g., Rahamani 1981; Curry 1984).

Cross-cultural study of famine foods.—The cross-cultural study of famine foods also provides a more subtle understanding of the intricate relationships between people and plants, interconnections which are not necessarily obvious from the ethnobotanical study of only one region or one population. The comparative study of famine foods has a simpler purpose and one with much practical value. Plants can be identified that are not recognized as edible within a single region, which, therefore, expands an area's practical ethnobotany.

A southwestern example includes two particularly loathsome plants. Goat's head or puncturevine *(Tribulus terrestris* L.) and burgrass *(Cenchrus* spp.) are thoroughly obnoxious weeds distributed throughout the Desert Borderlands and

whose mature fruits have sharp spines which cause much discomfort to humans and other animals; ''home owners and their dogs probably dislike punctureviné more than any other weed'' (Parker 1972:198). Few native or non–native inhabitants of the Desert Borderlands would recognize any value for these two taxa. Yet, these plants are described as important famine food worldwide. According to Bhandari (1974:75–77), both are important famine foods in the Rajasthan desert of India; goat's head is the ''chief food of the people during the Madras Famine,'' and burgrass is ''regarded as the most nutritious of famine foods.'' The Yoruba of West Africa also use goat's head as a famine food (Irvin 1952), and this plant, *chi li tzu,* is listed as a Chinese starvation food (Read 1946).

CONCLUSION

Famine foods have received little attention from ethnobotanists, relief workers, and others despite their importance throughout human history and the potential they may have for the future. Most records of their use are anecdotal and lack the detail necessary to understand their use. For example, describing the methods for the removal of toxic compounds from some famine foods is particularly important if these plants are to be used more widely, either as famine foods or in agriculture.

There are many types of famine foods, including agricultural byproducts not normally consumed, seed stock, and resources used only when more preferred foods are unavailable, either as seasonal hunger plants or used only during famines. The status of a resource as a famine food is not based solely on its biology and biochemical profile but rather also involves a range of social, cultural, political, and economic factors.

Documentation of Desert Borderlands famine foods is not as extensive as one could hope for. Yet several major categories do exist. The inner bark of some trees, such as pinyon pine, ponderosa pine, aspen, and one–seed juniper, is a major famine food, as are cacti, such as prickly pear and cholla. In addition, a number of other plants are recorded to have been used as starvation foods. These include pigweed, goosefoot, grass seeds, wild potato, globemallow, century plant, yucca, saltbushes, seepwillow, groundcherry, Rocky Mountain beeweed, bluedick, blazing star, Indian ricegrass, mistletoe, mesquite, screwbean, mangrove, rose, oak, jojoba, squaw currant, juniper, London rocket, eelgrass, nightshade, sow thistle, and others.

Many of the famine foods recorded for the Desert Borderlands are resources that we would expect to be used during food shortages. That is, most are very stable; they are perennials with an unusually effective ability to tolerate periods of low moisture, they have underground storage tissue, or they inhabit environments which are not affected by the common factors reducing resource abundance. The unexpectedly large number of annuals may reflect the historic change of hunger season plants becoming considered famine foods as a result of cultural transformations since European contact.

The brief consideration of famine foods from the Desert Borderlands of North America shows that patterns of the use of these foodstuffs changed through time

and can be an indicator of the history of changing diet. Specifically, once common aboriginal foods have become less preferred foods after domination by outside groups and with the subsequent introduction of Euro–Asian crops, new technologies, markets, and constraints on traditional catchments. It seems that these once common foods now have become famine foods for the ethnographically documented native populations of the Desert Borderlands.

Knowledge of traditional famine foods seems to be one of the first categories of native ethnobotanical information lost. Not only is this information easily lost, but it seems to be particularly difficult data to secure in the first place, perhaps partly due to the low status afforded those who must rely on such plants. Yet these plants have been critical to human survival and constitute an additional set of edible resources not normally recorded. And some of these plants may, in fact, have an as yet unrecognized economic potential. Therefore, loss of this particularly vulnerable information should concern us. The efforts to save traditional crop genotypes, knowledge of agricultural strategies and technology, and ethnobotanical information on common plant uses should also include the study of the least esteemed foods, those which have saved countless individuals and populations from starvation throughout human history.

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BOOK REVIEW

The Tropical Rain Forest: A First Encounter. Marius Jacobs, Remke Kruk et al. (editors). With a chapter on Tropical America by Roelof A.A. Oldeman and a Foreword by V.H. Heywood. New York: Springer–Verlag, 1988. Pp. 295, 157 figures and 8 plates. $39.95 (paper). ISBN 0–387–17996–8.

This most useful book is a translation of the original Dutch version that was published in 1981. The author, Marius Jacobs, died in 1983, when he was half way through preparation of the English version. Answering a clamor from interested people who wanted it finished and published, Dr. Remke Kruk and his colleagues decided to provide an English edition with a new addition on Tropical America. As Prof. Heywood states in his foreword: " . . . there is still a need for a scientifically sound text which could be used by students, conservationists and other biologists who want to obtain a balanced, well–written assessment of the problems and issues involved in this unique ecosystem."

The table of contents indicates the breadth of coverage in this book: (1) A matter of public awareness; (2) How rain forests are studied; (3) Climate; (4) Soils and cycles; (5) Trees; (6) Other life forms: (7) Compositon; (8) Primary and secondary forests; (9) Tropical America; (10) Malasia; (11) Tropical Africa; (12) Relationships of plants and animals; (13) Evolution; (14) Formation of species; (15) Fringes of the rain forest; (16) Rain forest values; (17) Damage and destruction; (18) Protection; (19) Forest and man. The very extensive list of references occupies ten pages of fine print, and the detailed index comprises ten pages.

Translation or revision of the chapters was done by numerous specialists and Chapter 9, devoted to Tropical America, was newly written by Professor R.A.A. Oldeman for this edition. Several of the chapters will be of special interest to ethnobiologists.

The underlying interest in this volume is its biological and humanistic viewpoints in dealing with rain forest problems. This characteristic of the book makes it useful to both technical and educated popular audiences. With the increasing scientific, international, governmental, and popular emphasis on the urgency of conservation of rain forests, there can be no doubt about the wide acceptance and extraordinary value of this book.

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RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS: FALL 1990–FALL 1991

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This is the ninth in an annual series of bibliographies listing selected dissertations drawn from the pages of Dissertation Abstracts (D.A.). All listings were made by scanning the titles and abstracts published in D.A. and making subjective decisions as to which ones might be relevent to work in ethnobiology or related disciplines such as ecological anthropology and economic botany.

Dissertations categorized in D.A. under Anthropology, Geography, American Studies, Agricultural Economics, Linguistics, Language, Sociology, Ecology, Biology, Botany, Zoology, Chemistry, Paleoecology, Health Science, Home Economics, Physical Geography, and Agriculture were considered for inclusion in the list. An attempt was made to be as inclusive as possible, but some dissertations may have been overlooked. Comments and suggestions would be welcome for items to include in next year's edition.

Dates covered by the present paper include: Volume A (Humanities and social Sciences): September 1990–August 1991; Volume B (Sciences and Engineering): September 1990–August 1991; Volume C (European Dissertations): Spring 1990–Summer 1991. Note that these are the dates for the issues of D.A. in which the abstracts appear, rather than the dates of acceptance of the dissertations themselves.

The dissertations are listed alphabetically below, along with the year of acceptance, title, institution, length, advisor or major professor, number of the page in D.A. in which the abstract may be found, University Microfilms order number, and the ISBN number, when this information was included.

Most of the dissertations accepted at institutions in the United States and some of those from Australia, Canada, South Africa, and the United Kingdom may be obtained from University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106, either on microfilm or published by microfilm xerography. Quality of printed matter is generally excellent, but that of figures and photographs varies with the quality of the original. Current prices may be obtained by calling 800–521–3042, 313–761–4700 from Alaska, Hawaii, or Michigan, or 800–268–6090

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RESUMEN.—En este bibliografía se incluyen disertaciones recientes de interés a los etnobiólogos. Por cada uno se da el número de la página donde se halla el resumen en Dissertation Abstracts (D.A.), y el número de encargar un ejemplar de la disertación de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106 USA (telefono: 313–761–4700 o 800–521–3042; desde Canada 800–268–6090).

RESUME.—Cette bibliographie comprend quelques dissertationes recentes d'interet aux ethnobiologistes. Chez chaqu–une on donne le numéro de la page où se trouve le résumé dans Dissertation Abstracts (D.A.), et le numéro de commander un exemplaire de la dissertations de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106 USA (telephone: 313–761–4700 ou 800–521–3042; de Canada 800–268–6090).

Abdoellah, Oekan Soekotjo. 1990. Indonesian transmigrants and adaptation: an ecological anthropological perspective. University of California, Berkeley, 230 pp. D.A. 51(9):3119–3120–A. Order no. DA9103621.

Abou–Shoer, Mohamed Ibrahim. 1987. Isolation and structure elucidation of cytotoxic agents from the higher plant *Psorospermum febrifugum* [and *Cephalotaxus harringtonia*]. Purdue University, 169 pp. D.A. 51(9):4294–B. Order no. DA9105003.

Abrahamse, Tanya. 1988. Perception of pests and pest management and pest control decision making in development agriculture: Tonga farmers of the Mazabuka District, Zambia, 1981–1982: a case study. Council for National Academic Awards (U.K.), 485 pp. D.A. 50(4):1159–B. Order no. BRDX85560.

Adiwilaga, Kartika Dorothea. 1989. Introgression of tetraploid Mexican wild species germplasm into cultivated potato gene pool. Washington State University, 79 pp. D.A. 51(4):1555–B. Order no. DA9025385.

Allen, Craig Daniel. 1989. Changes in the landscape of the Jemez Mountains, New Mexico. University of California, Berkeley, 356 pp. D.A. 51(5):2169–B. Order no. DA9028713.

Andrews, Elizabeth Frances. 1989. The Akulmiut: territorial dimensions of a Yup'ik Eskimo society. University of Alaska, Fairbanks, 570 pp. Supervisor: Linda J. Ellanna. D.A. 51(4):1285–A. Order no. DA9017193.

Arokiasamy, Charles Maria Victor. 1987. The history of rehabilitation services in West Malaysia from 1957 to 1982. Southern Illinois University, Carbondale, 263 pp. D.A. 52(1):182–B. Order no. DA9117453.

Arslanian, Robert Lance. 1990. Iridoids and alkaloids from plants of the western United States *[Castilleja, Zanthoxylum, Penstemon]*. Colorado State University, 208 pp. 52(1):237–B. Order no. DA9117158.

Backstrand, Jeffrey Robert. 1990. Patterns of household food consumption in rural, central Mexico. University of Connecticut, 513 pp. Major adviser: Pertti J. Pelto. D.A. 52(2):583–584–A. Order no. DA9119503.

Bebbington, Anthony James. 1990. Indigenous agriculture in the central Ecuadorian andes: the cultural ecology and institutional conditions of its construction and its change. Clark University, 326 pp. Chief instructor: B.L. Turner, II. D.A. 51(10):3487–A. Order no. DA9107524.

Bellon–Corrales, Mauricio Rafael. 1990. The ethnoecology of maize production under technological change. University of California, Davis, 289 pp. D.A. 51(8):2793–A. Order no. DA9102056.

Boisnard, Juliette. 1989. Contribution à l'étude d'un médicament homéopathique: opium. [Contribution to the study of a homeopathic drug: opium]. Université de Dijon (France), 59 pp. Dissertation and abstract in French. D.A. 51(1): 87–C.

Borré, Kristen Sue. 1990. A biocultural model of dietary decision–making among the North Baffin Island Inuit: explaining the ecology of food consumption by native Canadians. University of North Carolina, Chapel Hill, 452 pp. Director: Bruce P. Winterhalder. D.A. 51(7):2441–A. Order no. DA9034676.

Botterill, Elizabeth Mary. 1988. A palaeoecological study of Cors Gyfelog and Tre'r Gof: lowland mires in northwest Wales. University of Keele (U.K.), 280 pp. D.A. 51(6):2795–B. Order no. BRDX89595.

Butler, Virginia Lalon. 1990. Distinguishing natural from cultural salmonid deposits in Pacific Northwest North America. University of Washington, 238 pp. Chairperson: D.K. Grayson. D.A. 52(2):581–A. Order no. DA9117934.

Cerf, Charlotte. 1990. Waters of change: the impact of industrial water pollution on an artisanal fishing community in northeastern Brazil. Columbia University, 238 pp. Sponsor: Robert F. Murphy. D.A. 52(2):584–A. Order no. DA9118538.

Chaar, José Merched. 1990. Extraction of caffeine from seed of guarana *[Paulinia cupana* var. *sorbilis]* fruit. University of Tennessee, 140 pp. D.A. 51(6):2688–B. Order no. DA9030692.

Chandler, Paul Michael. 1990. Ecological knowledge in a traditional agroforest management system among peasants in China. University of Washington, 300 pp. Chair: Robert G. Lee.

Christenson, Lynne Elizabeth. 1990. The Late Prehistoric Yuman people of San Diego County, California: their settlement and subsistence system. Arizona State University, 342 pp. Chair: Geof Clark. D.A. 51(8):2790–A. Order no. DA9101865.

Clay–Poole, Scott Travis. 1989. Pollen flora and paleoecology of Holocene alluvial Tsegi and Naha Formations, northeast Arizona. Northern Arizona University, 120 pp. D.A. 51(5):2257–B. Order no. DA9028173.

Colby, Michael Ellsworth. 1990. Ecology, economics, and social systems: the evolution of the relationship between environmental management and development. University of Pennsylvania, 382 pp. D.A. 51(5):2262–B. Order no. DA9026539.

Crosby, Victoria Mary. 1989. Agricultural change in later prehistoric and Roman Britain. University of Southampton (U.K.), 695 pp. D.A. 52(1):199–A. Order no. BRDX92254.

Cummings, Linda Scott. 1989. Coprolites from medieval Christian Nubia: an interpretation of diet and nutritional stress. University of Colorado, Boulder,

217 pp. Director: Dennis P. Van Gerven. D.A. 51(4):1282–A. Order no. DA9024823.

Dahl, Kathleen Alison. 1990. Sovereignty, environmental use, and ethnic identity on the Colville Indian Reservation. Washington State University, 264 pp. Chair: John H. Bodley. D.A. 51(9):3120–3121–A. Order no. DA9102843.

Davelouis, José Raúl. 1990. Green manure applications to minimize aluminum toxicity in the Peruvian Amazon. North Carolina State University, 128 pp. D.A. 51(4):1557–B. Order no. DA9023371.

Davis, Bertell David. 1990. Human settlement in pristine insular environments: a Hawaiian case study from Barbers Points, southwestern O'ahu. University of Hawaii, 385 pp. Chair: P. Bion Griffin. D.A. 52(1):199–A. Order no. DA9118033.

Delacorte, Michael Gibson. 1990. The prehistory of Deep Springs Valley, eastern California: adaptive variation in the western Great Basin. University of California, Davis, 446 pp. D.A. 51(8):2790–A. Order no. DA9102069.

Dettmer, Sharon Denise. 1990. Delivering primary health care to rural communities in rural Peru. Syracuse University, 375 pp. D.A. 52(2):773–774–B. Order no. DA9119419.

Dowell, Mary Susan. 1990. People's expectations of their medications: an ethnographic study. University of Texas, Austin, 224 pp. D.A. 52(1):159–B. Order no. DA9116849.

Drew, Judith C. 1990. A nursing study of health and illness beliefs, explanatory models, and help–seeking patterns among Franco–Americans. University of Texas, Austin, 352 pp. D.A. 52(1):159–B. Order no. DA9116850.

Dyer, Christopher Louis. 1990. Sharing the fishing: resource utilization and kinship cooperation in three Mexican artisanal fishing communities. Arizona State University, 296 pp. D.A. 51(4):1286–A. Order no. DA9025756.

Eldridge, Stuart Allyn. 1990. Ceramic Period occupation of the central Maine coast: hunter–gatherer estuarine adaptations in the St. George River drainage. University of Pennsylvania, 328 pp. Supervisor: Robert J. Sharer. D.A. 51(12):4166–4167–A. Order no. DA9112555.

Emerson, Alice Marie. 1990. Archaeological implications of variability in the economic anatomy of *Bison bison*. Washington State University, 937 pp. Chair: William D. Lipe. D.A. 51(9):3118–A. Order no. DA9102847.

Everts, Dana L. 1990. Women are flowers: the exploration of a dominant metaphor in Isthmus Zapotec expressive culture. Indiana University, 483 pp. Chair: Mary Ellen Brown. D.A. 51(10):3487–A. Order no. DA9107274.

Faber, Daniel Richard. 1989. Imperialism and the crisis of nature in Central America. University of California, Santa Cruz, 433 pp. D.A. 51(4):1409–4101–A. Order no. DA9021407.

Fellah, Abdulmunam Mohamed. 1990. The nutritional value and toxic properties of buffalo gourd *(Cucurbita foetidissima)* plant. University of Arizona, 148 pp. D.A. 51(12):5655–B Order no. DA9111932.

Fondahl, Gail Andrea. 1989. Native economy and northern development: reindeer husbandry in Transbaykalia. University of California, Berkeley, 399 pp. Chair: David J.M. Hooson. D.A. 51(5):1725–1726–A. Order no. DA9028823.

Frame, Dawn Maria. 1990. A revision of *Schoenocaulon* (Liliaceae: Melianthieae). City University of New York, 297 pp. D.A. 51(11):5122–B. Order no. DA9108103.

Ghaleb, Abdu O. 1990. Agricultural practices in ancient Radman and Wadi al-Jubah (Yemen). University of Pennsylvania, 548 pp. Supervisor: Erle V. Leichty. D.A. 51(8):2790–A. Order no. DA9101160.

Gildesgame, Myron Leo. 1990. Conserving tropical forest resources in the national park system of Costa Rica. Clark University, 205 pp. D.A. 51(9):4251–B. Order no. DA9026080.

Good, Kenneth Robert. 1989. Yanomami hunting patterns: trekking and garden relocation as an adaptation to game availability in Amazonia, Venezuela. University of Florida, 191 pp. Chair: Marvin Harris. D.A. 51(3):909–A. Order no. DA9021853.

Green, Gina C. 1989. Conservation and natural resource projects in Central America: an analysis to determine the ingredients for success. University of Oxford (U.K.), 357 pp. D.A. 52(1):35–B. Order no. BRD–92343.

Gremillion, Kristen Johnson. 1989. Late prehistoric and historic period paleoethnobotany of the North Carolina Piedmont. University of North Carolina, Chapel Hill, 383 pp. Director: Richard A. Yarnell. D.A. 51(6):2066–A. Order no. DA9032969.

Guibourdenche, Sylvie Calame. 1990. Le guarana: *Paulinia cupana* H.B.K. var. *sorbilis* (Mart.) Ducke, une drogue à caféine de la famille des Sapindacees [Guarana: *Paulinia cupana* H.B.K. var. *sorbilis* (Mart.) Ducke, a caffeine drug of the family Sapindaceae]. Université de Dijon (France), 141 pp. Dissertation and abstract in French. D.A. 52(1):102–C.

Guptill, Katharine Schuyler. 1990. Evaluation of an infant weaning food intervention in Kwara State, Nigeria. Johns Hopkins University School of Public Health and Hygiene, 379 pp. D.A. 51(7):3331–B. Order no. DA9030682.

Hale, Howard Stephen. 1989. Prehistoric subsistence strategies and settlement patterns in the Lake Okeechobee basin of the south Florida peninsula. University of Florida, 251 pp. Chair: Elizabeth S. Wing. D.A. 51(5):1668–1669–A. Order no. DA9028521.

Ham, Adrienne Camille. 1990. Bamboo housing in Costa Rica: an analysis of a pilot program. Texas Tech University, 200 pp. D.A. 51(9):4306–B. Order no. DA9104808.

Hasenstab, Robert John. 1990. Agriculture, warfare, and tribalization in the Iroquois homeland of New York: a G.I.S. analysis of Late Woodland settlement. University of Massachusetts, 402 pp. Directors: Dena F. Dincauze, H. Martin Wobst. D.A. 51(7):2434–A. Order no. DA9035389.

Haslam, Christopher John. 1987. Late Holocene peat stratigraphy and climatic change: a macrofossil investigation from the raised mires of northwestern Europe. University of Southampton (U.K.), 328 pp. D.A. 51(7):3297–B. Order no. BRDX90505.

Henriot, Jean–Michel. 1989. La sangsue *Hirudo medicinalis:* Ø tilisations cliniques de l'animal; perspectives thérapeutiques de l'hirudine [The leech *Hirudo medicinalis:* clinical uses of the animal; therapeutic viewpoints of leeching].

Université de Dijon (France), 119 pp. Dissertation and abstract in French. D.A. 51(1):88–C.

Herrick, Bruce Robert. 1990. Modeling land use change in Northern India, 1880–1980. University of Wisconsin, Madison, 186 pp. D.A. 51(12):5789–B. Order no. DA9108716.

Hershkovitz, Mark Alan. 1990. Phylogenetic and morphological studies in Portulacaceae. University of California, Davis, 284 pp. D.A. 51(11):5122–B. Order no. DA9110640.

Hill, Alison. 1990. Ecology and classification of the pinyon–juniper woodlands in western New Mexico. New Mexico State University, 75 pp. D.A. 51(11): 5116–B. Order no. DA9111293.

Horwitz, Victoria Diana. 1990. Maritime settlement patterns in southeastern Tierra del Fuego (Argentina). University of Kentucky, 323 pp. Director: Tom D. Dillehay. D.A. 51(7):2434–A. Order no. DA9034184.

Howell, James Allen. 1990. Variation and evolution of Bambara groundnut *(Vigna subterranea* (L.) Verdci; Fabaceae). Miami University, 251 pp. D.A. 51(6):2720–B. Order no. DA9029376.

Hubbard, Nicola N. 1988. Holocene settlement in the western Cape, South Africa: an environmental approach. (Volumes I and II). University of Oxford (U.K.), 623 pp. D.A. 51(11):3797–A. Order no. BRD–91736.

Huckell, Bruce Benjamin. 1990. Late preceramic farmer–foragers in southeastern Arizona: a cultural and ecological consideration of the spread of agriculture into the arid southwestern United States. University of Arizona, 409 pp. Director: Charles F. Hutchinson. D.A. 51(12):4167–A. Order no. DA9114060.

Hunt, Eleazer Douglass. 1990. A consideration of environmental, physiolographic and horticultural systems as they impact Late Woodland settlement patterns in western New York State: a geographic information system (G.I.S.) analysis of site location. State University of New York, Buffalo, 347 pp. D.A. 51(8): 2791–A. Order no. DA9033705.

Jiang, Qingping. 1990. A study of diterpenois alkaloids from *Aconitum palmatum* Don. and a total synthesis of radermachol. University of Georgia, 150 pp. D.A. 51(10):4846–B. Order no. DA9107198.

Johnson, Brooke Ronald, Jr. 1990. Nomadic networks and pastoral strategies: surviving and exploiting local instability in south Turkana, Kenya. State University of New York, Binghampton, 242 pp. D.A. 51(6):2070–A. Order no. DA9033117.

Jones, David Alyn. 1984. An ecological interpretation of Mesolithic shellfish remains on the island of Oronsay, Inner Hebrides (Volumes I and II). University of Sheffield (U.K.) 487 pp. D.A. 52(2):582–A. Order no. BRDX92497.

Kelley, David Baskin. 1990. Coles Creek period faunal exploitation in the Ouachita River valley of southern Arkansas: the evidence from the Paw Paw site. Tulane University, 216 pp. Chair: Tristram R. Kidder. D.A. 51(6):2067–A. Order no. DA9032516.

Krabacher, Thomas Scott. 1990. Fishing, food, and change along the Sherbro Coast of Sierra Leone. University of California, Davis, 416 pp. Adviser: Frederick J. Simoons. D.A. 51(5):1726–A. Order no. DA9026837.

Kummer, David M. 1990. Deforestation in the postwar Philippines. Boston University, 282 pp. Major Professor: Chi Ho Sham. D.A. 51(4):1346–A. Order no. DA9023765.

Kuznar, Lawrence Anthony. 1990. Economic models, ethnoarchaeology, and early pastoralism in the high sierra of the south central Andes (Volumes I and II). Northwestern University, 479 pp. Adviser: Mark S. Aldenderfer. D.A. 51(6):2067–A. Order no. DA9031947.

Langeron, Marie–Hélène. 1988. A propos de l'utilisation du bétel, de la coca, de la cola, et du khat comme masticatoires dans leur pays d'origine [On the use of betel, coca, cola, and khat as masticatories in the countries of origin]. Université de Dijon (France), 128 pp. Dissertation and abstract in French. D.A. 51(1):94–C.

Lightfoot, Dale Robert. 1990. The prehistoric pebble–mulched fields of the Galisteo Anasazi: agricultural innovation and adaptation to environment. University of Colorado, Boulder, 331 pp. Director; Gary L. Gaile, D.A. 52(1):200–A. Order no. DA9117062.

Lundberg, Emily Ruth. 1989. Preceramic procurement patterns at Krum Bay, Virgin Islands. University of Illinois, Urbana–Champaign, 376 pp. D.A. 51(4):1283–1284–A. Order no. 9010945.

Marshall, Jeremy H. 1989. Natural classification and the reality of higher taxa. University of Oxford (U.K.), 162 pp. D.A. 51(9):4144–B. Order no. BRD91447.

Martínez, Homero. 1991. Fluid and food management of acute diarrhea in rural Mexico: ethnography and clinical trial of an indigenous beverage [from rice–powder; also herbal teas]. Cornell University, 285 pp. D.A. 51(12):5814–B. Order no. DA9113297.

Martinez, Marie–Françoise. 1990. Les crotons: plantes toxiques ou plantes médicinales? [The crotons: toxic or medicinal plants?] Université de Dijon, 80 pp. Dissertation and abstract in French. D.A. 51(3):434–C.

Maruo, Kanehira. 1989. Jordbruksutveckling och Shang Yangs reformer. [Agricultural development and Shang Yang's reforms]. Göteborgs Universitet (Sweden), 539 pp. In Swedish; abstract in English. D.A. 51(3):355–C.

Masse, William Bruce. 1990. The archaeology and ecology of fishing in the Belau Islands, Micronesia. Southern Illinois University, Carbondale, 754 pp. Major Professor: George J. Gumerman. D.A. 52(1):200–A. Order no. DA9117421.

Matiskainen, Heikki Olavi. 1989. Studies on the chronology, material culture, and subsistence economy of the Finnish Mesolithic, 10,000–6000 B.P. Helsingin Yliopisto (Finland), 189 pp. D.A. 51(2):185–C. ISBN 951-9056-91-2.

Maxwell, Bruce Dale. 1990. The population dynamics and growth of salmonberry *(Rubus spectabilis)* and thimbleberry *(Rubus parviflorus).* Oregon State University, 303 pp. D.A. 51(6):2723–B. Order no. DA9032683.

McDonald, Darrel Lee. 1990. The historical cultural plant geography of urbanized Galveston: implications of gardening on a subtropical barrier island (Volumes I and II). Texas A&M University, 449 pp. Chair: Clarissa Kimber. D.A. 52(2):645–A. Order no. DA9118272.

McGoun, William Elliott. 1989. Prehistoric peoples of South Florida. University of Florida, 183 pp. Chair: Jerald T. Milanich. D.A. 51(3):905–A. Order no. DA9021881.

McJunkin, David Morgan. 1991. Logwood: an inquiry into the historical biogeography of *Haematoxylum campechianum* L. and related dyewoods of the neotropics. University of California, Los Angeles, 785 pp. D.A. 51(12):5786–B. Order no. DA9113559.

Middleton, David J. 1989. Taxonomic studies in the genus *Gaultheria* L. and related genera (Ericaceae). University of Aberdeen (U.K.), 348 pp. D.A. 51(10):4678–B. Order no. BRDX91623.

Moench, Marcus Henry. 1990. From forest to agroforest: landuse dynamics and crop succession in the Western Ghats of Kerala, South India. University of California, Berkeley, 431 pp. D.A. 51(9):4258–B. Order no. DA9103822.

Moore, Michael O'Connor. 1990. A systematic study of eastern North American *Vitis* (Vitaceae) north of Mexico. University of Georgia, 263 pp. D.A. 51(8): 3653–B Order no. DA9100703.

Morey, Darcy Franklin. 1990. Cranial allometry and the evolution of the domestic dog. University of Tennessee, 328 pp. Advisor: Walter E. Klippel. D.A. 51(12):4168–A. Order no. DA9112869.

Moss, Madonna Lee. 1989. Archaeology and cultural ecology of the prehistoric Angoon Tlingit. University of California, Santa Barbara, 508 pp. Chair: Michael A. Glassow. D.A. 51(3):906–A. Order no. DA9021951.

Mouer, Lloyd Daniel. 1990. The Archaic to Woodland transition in the Piedmont and coastal plain sections of the James River Valley, Virginia. University of Pittsburgh, 396 pp. Chairperson: James B. Richardson, III. D.A. 51(11): 3797–A. Order no. DA9109438.

Nakagaki, Barbara Jean. 1990. An evaluation of three insect species as a source of feed and food. University of Wisconsin, Madison, 86 pp. D.A. 51(9): 4166–B. Order no. DA9101549.

Narvaez–Melo, Juan Manuel Fernando. 1990. Maturation, deterioration, storability, and quality evaluation of seed of two species of amaranth. Mississippi State University, 110 pp. 51(1):5085–B. Order no. DA9109002.

Nestel, David. 1990. Comparative ecology of monocrop and polycrop coffee systems in Veracruz, Mexico. University of California, Berkeley, 191 pp. D.A. 51(10):4682–B. Order no. DA913829.

Newman, Jonathan Adam. 1990. Foraging in a random environment: a stochastic dynamic programming approach. State University of New York, Albany, 196 pp. D.A. 51(4):1615–B. Order no. DA9024944.

Nicholas, George Peter. 1990. The archaeology of early place: early postglacial land use and ecology at Robbins Swamp, northwestern Connecticut. University of Massachusetts, 281 pp. Director: Dena F. Dincauze. D.A. 51(11): 3797–3798–A. Order no. DA9110196.

Noravelle, Michael Eugene. 1990. A model for sustainable management of livestock on the commons: a comparative analysis of two types of Apache Indian cattle associations. University of Arizona, 206 pp. D.A. 51(4):1590–B. Order no. DA9024653.

Panero, José Luís. 1990. A monograph of the Andean genus *Pappobolus* [Asteraceae]. University of Tennessee, 445 pp. D.A. 51(6):2721–B. Order no. DA9030731.

Park, Wonkyu. 1990. Development of anatomical tree-ring chronologies from southern Arizona conifers using image analysis. University of Arizona, 234 pp. D.A. 51(7):3209-B. Order no. DA9100047.

Payne, Allen Matthew. 1990. Synthesis and isolation of constituents from aquatic plants *[Heritiera littoralis, Aegiceras corniculatum,* and *Juncus roemerianus].* Mississippi State University, 225 pp. D.A. 51(11):5322-B. Order no. DA9108965.

Pérez, Berta Elena. 1990. Ideology of the animal rights movement. University of Minnesota, 156 pp. D.A. 51(11):3802-3803-A. Order no. DA9109203.

Pineda Colorado, Ramón. 1990. Quantitative and genetic analysis in *Solanum chacoense* Britt. using inbred lines. University of Wisconsin, Madison, 200 pp. D.A. 51(11):5139-B. Order no. DA9034841.

Potter, Daniel. 1991. Systematic studies of *Sphenostylis* and *Nesphostylis* (Leguminosae: Phaseoleae). Cornell University, 283 pp. D.A. 51(12):5685-B. Order no. DA9113313.

Prabowo, Akhmad. 1989. Evaluation of the mineral status of grazing ruminants in South Sulawesi, Indonesia. University of Florida, 237 pp. D.A. 51(5): 2135-B. Order no. DA9028558.

Promsattha, Rattanaporn. 1990. Chemical and behavioral studies on hairpencil secretions from male black cutworm moths, *Agrotis ipsilon* (Hufnagel) and chemical study of two medicinal plants *[Erythrina sigmoidea* and *Garcinia epunctata].* University of Missouri, Columbia. D.A. 51(8):3859-B. Order no. DA9100224.

Purnama, Boen Muchtar. 1990. Rural households: energy consumption in Central Java, Indonesia. Michigan State University, 173 pp. D.A. 51(9):4130-B. Order no. DA9102720.

Quetin-Leclercq, Joëlle. 1989. Détection, purification et analyse structurale d'alcaloïdes indoliques [du *Strychnos]:* étude des effets cytotoxiques poroduits par certains d'eux [Detection, purification, and structural analysis of indole alkaloides from *Strychnos:* study of the cytotoxic effects produced by certain of these]. Université de l'Etat à Liège (Belgium), 157 pp. In French; abstract in English. D.A. 51(1):95-C.

Rao, Meenakshi Srikumar. 1990. Studies towards the total synthesis of taxol: synthesis of A-ring intermediate with all the latent functionalities. City University of New York, 97 pp. D.A. 51(11):5323-B. Order no. DA9108166.

Rapson, David John. 1990. Pattern and process in intrasite spatial analysis: site structural and faunal research at the Bugas-Holding site. University of New Mexico, 464 pp. Director: Lewis R. Binford. D.A. 51(10):3447-A. Order no. DA9106603.

Rautman, Alison Eunice. 1990. The environmental context of decision-making: coping strategies among prehistoric cultivators in central New Mexico (Volumes I and II). University of Michigan, 584 pp. Chair: John D. Speth. D.A. 52(1):201-A. Order no. DA9116278.

Raven, Michelle Mihran. 1990. The point of no diminishing returns: hunting and resource decline on Boigu Island, Torres Strait. University of California, Davis, 334 pp. D.A. 51(8):2795-A. Order no. DA9102105.

Redmond, Brian G. 1990. The Yankeetown Phase: emergent Mississippian cultural adaptation in the lower Ohio River Valley. Indiana University, 357 pp. Chairperson: Christopher S. Peebles. D.A. 51(11):3798–A. Order no. DA9109756.

Regnéll, Joachim. 1989. Vegetation and land use during 6000 years: palaeoecology of the cultural landscape at two lake sites in southern Skåne, Sweden. Lunds Universitet (Sweden), 62 pp. D.A. 51(1):49–C.

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SHORT COMMUNICATION

A PRELIMINARY OVERVIEW OF CULTURAL ENTOMOLOGY IN MONGOLIAN LIFE

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INTRODUCTION

Cultural entomology is the influence of insects on cultures exemplified in literature, language, music, the arts, interpretive history, religion, and recreation (Hogue 1987:181)[1].

The Mongols, once dispersed across much of Central Asia as a result of the successes of the thirteenth century conqueror Genghis Khan (1162–1227), are now concentrated in China (Mongolian People's Republic) and the USSR (Kalymk and Buryat Republics). From time immemorial, nomadic Mongols have lived intimately with nature. Thus, insects figure prominently in Mongol culture, where generally they are seen as small and ignoble. However, some insects, such as the butterfly, represent beauty. Butterflies are frequently portrayed in paintings (on doors of cabinets and table-tops) and in needlework and carpets[2].

In this paper we examine six insects which often appear in Mongol folklore, art, and literature: the ant, honey bee, mosquito, louse, fly, and katydid. Our sources include Mongolian and Chinese language materials dealing with folktales, poetry, and art.

THE ANT

The ant symbolizes working cooperatively, the dangers of pride, and the merits of hard work. In the tale "The Tiger and the Ant,"[3] a tiger and ants fight. The tiger is soon covered by the ants and at last is forced to entreat the ants to spare him. The story concludes with the axiom: "Though you may be powerful, you are alone. And if you are small and weak, if you are united, you can defeat

any powerful enemy.'' This was relevant to Mongols in the process of empire-building and later, after the fall of the Yuan Dynasty (1270–1368), when they became progressively weaker and divided.

In ''The Elephant and Ants,'' the dangers of pride are taught (Rinchindongrob 1987:108). An elephant saw many ants transporting grains one at a time and said, ''How weak you are, carrying grain with such difficulty.'' The ants responded, ''Even if you are stronger, you can't do what we are doing.'' Enraged, the elephant said ''Let me do this work all at one time,'' then unsuccessfully tried to pick up the grain with its trunk. The ants said, ''Let us do this work by ourselves. There is a skill for every job.''

Another account showing the value of hard work has ants constructing a nest one beautiful summer day (Rinchindongrob 1987:162). A grasshopper at play happened to see them and said, ''How stupid. While I play in this nice weather you work and can't enjoy yourselves.'' Suddenly it began raining, injuring the grasshopper. But the ants were safe in their nest.

The ant does not always appear so positively, however. Folklore says that the ant's abdomen is thread-like because it and a dragon competed with the winner destined to be the king of all animals. Because the dragon was much longer, the ant lay down and stretched. As a result, part of his abdomen became thread-like. The moral is that it is dangerous to attempt foolish things (Rinchindongrob 1987:141).

THE HONEY BEE

The value of unity is demonstrated in the story ''The Honey Bees Battle A Wild Pig.'' A weary and hungry wild pig slept on a hive of wild honey bees who were away at work. One bee then asked the pig to leave. The pig replied, ''I'm hungry. Lead me to honey.'' The bee returned to the bee leader and reported what had transpired. The bee leader then angrily led all the bees to the wild pig and told him to leave peacefully so that their friendship would not be lost. The pig replied rudely, ''You little animals wish to frighten me, well, I'll destroy your nest.'' But the honey bees swarmed about, stinging it. In great pain, the pig could only run crazily away. The honey bees returned to their work (Rinchindongrob 1987:55).

''The Shepherd and the Honey Bee'' (Degujia and Gowa 1984:410) teaches kindness. One day a shepherd saved a hive of bees from a flood. The bees thanked him and said, ''When you are in distress, call us.'' Some days later a wolf pack attacked his sheep. Recalling the bees' promise, he called them. Many appeared and stung the wolves into retreat. Later, when he reached the age of marriage, he heard that a beautiful girl would marry. When he reached her home he found that her parents had announced that she would marry the man who could identify her in a covered cart among 100 similar carts. With the faithful bees' help, he chose the right girl whom he then married.

The above demonstrate a benevolant attitude toward the honey bee which is further confirmed by the common saying, ''A place where bees enjoy themselves,'' which indicates a beautiful place with favorable weather, and as a result bees, which stand for cleanliness and beauty, come (Toronga and Urgen 1984:194).

THE MOSQUITO, LOUSE, FLY, AND KATYDID

These four are viewed differently from the insects discussed above. The mosquito symbolizes dirtiness and ugliness. It is a monster transformed (Toronga and Urgen 1984:141). The expression "A place where lice crowd" suggests a dirty and ugly place (Toronga and Urgen 1984:206). Also the expression "A net which a fly cannot even pass through," suggests something that is small and causes man to be ignorant (Toronga and Urgen 1984:94).

The katydid or long-horned grasshopper also exemplify ugliness and dirtiness (Toronga and Urgen 1984:254), partly because of the animal's large abdomen. However, in the award-winning Mongolian poem "Sound of the Katydid," the katydid is a nostalgic reminder of the grassland to a Mongol trapped in an unpleasant city life.

Sound of the Katydid[4]

On a hot summer's night
    no sleep
    poems
Little green katydid
Why do you sing
    the whole night through?!
Country animal—
Moaning
    because of hot city weather?!
Groaning
    because of missing your country home?!
Upset
    because of missing every morning dew?!
Groaning
    because of missing every evening grassland breeze?! ...

Katydid on the balcony
    singing
    crying ...
Can't you be quiet
As I am?!
Poor thing

CONCLUSION

Mongol cultural attitudes toward the insects which we have discussed may be summarized as follows: The ant symbolizes the benefits of working together and of hard work and the dangers of pride. The honey bee stands for unity, cleanliness and beauty, and the value of kindness. The mosquito, louse, fly, and katydid symbolize ugliness and dirtiness. As we indicated previously, this paper is the most cursory treatment of this topic. Mongols show considerable variation depending on the geographical area in which they dwell and a great deal of fieldwork is needed to be able to better deal with the richness of this topic. In

the future, we hope to further research this topic and also research Mongolian folk taxonomy.

NOTES

[1]Hogue (1987) classified insects used in medicine as "applied entomology." For a discussion of insects used in Mongolian medicine see Narsu and Stuart (1987:7–13).

[2]For examples of butterfly patterns used in shoes and boots, see Inner Mongolia Museum (1987:84, 86–87). For examples of butterfly patterns in Tu (Monguor, White Mongol) embroidery see Ye and Cao (1987:68–69, 92, 96). For butterfuly carpet, table, and cabinet patterns see Agewang (1963:2, 11) and Culture Bureau of Inner Mongolia (1960:39, 55).

[3]We thank Nasanbayer of the Inner Mongolia Social Science Academy for this translation.

[4]Inner Mongolia Autonomous Region's Editorial Committee of Modern Literature 1986:355.

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ABSTRACTS

of presentations (contributed papers and poster sessions) at the Fourteenth Annual Conference of the Society of Ethnobiology

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Kay ANDERSON, Forestry & Resource Management/University of California, Berkeley

FROM BURNS TO BASKETS: DEERGRASS ETHNOECOLOGY

Deergrass *(Muhlenbergia rigens)* is a perennial native bunchgrass found in scattered colonies in damp places below 7,000 feet in many California plant communities. Deergrass was the most important grass utilized by California Indians historically in the foundations of coiled baskets. Today contemporary weavers in various tribes still gather deergrass flowerstalks for basketry material. The ecology, indigenous use, and management of this plant are discussed in light of recent ethnographic, ethnohistoric, and ecological field research findings. Additionally, results of experiments conducted in Yosemite National Park designed to "mimic" traditional Indian patterns are highlighted.

Kurt F. ANSCHUETZ, Museum of Anthropology, University of Michigan, Ann Arbor

NATURAL PERIODICITY AND HUMAN AGENCY: REEVALUATING THE ANASAZI ABANDONMENT OF THE GALLINA DISTRICT, NEW MEXICO

Archaeologists have traditionally cited the trend toward increasingly xeric conditions and the subsequent breakout of internecine warfare as the principal factors underlying the Anasazi abandonment of the Gallina District during the thirteenth century A.D. These arguments, however, are unsatisfactory because they fail to consider how low-level cultural responses to decreased precipitation heightened conditions of subsistence stress by adversely affecting the availability of other critical subsistence resources. The failure of these actions contributed, in turn, to the necessity for human populations to adopt a higher-order adaptive response of regional abandonment. In this paper I use archaeological and paleoclimatological evidence to evaluate the systemic interrelationships between changes in precipitation periodicity and increased maize agricultural risk, on the one hand, and the consequences of cultural decisions to intensify the hunting of large game animals, such as elk and mule deer, on the other.

Bruce F. BENZ, Luis ROBLES H., Domatila DE NIZ L., Rosario PINEDA L., Judith CEBALLOS Z., Francisco SANTANA M., and Analilia CARDENAS T., Laboratorio Natural Los Joyas, University of Guadalajara

ETHNOBOTANICAL INVESTIGATION AMONG MESTIZOS OF SOUTHERN JALISCO AND COLIMA

Ethnobotanical research in the Sierra de Manantlan seeks to promote a local conservation ethic through documentation of existing knowledge and use of the local flora by the rural mestizo populations. Use and knowledge of the native plant species have been documented through interviews with more than 150 informants in 10 rural communities over a two-year period. Informants were selected on the basis of their thematic knowledge and willingness to collaborate. Over half of the more than 560 plant species used in interviews were reported to be employed for one or more uses.

While corroborating use of many species by employing numerous informants, we note that a large amount of empirical knowledge is apparently not shared among informants residing in the same community and even less is shared between communities even when the same vegetation types are available locally. For example, as many as 30% of the species said to be of medicinal value are reported as such by only a single informant. This pattern is apparent independent of the community or general use-category examined. Such idiosyncratic variability may stem from active experimentation or from erosion of traditional knowledge by the surrounding nontraditional societies.

Kenneth P. CANNON, Midwest Archeological Center, Lincoln, NE

MULTIVARIATE METRIC ANALYSIS OF BISON REMAINS FROM GRAND TETON NATIONAL PARK, WYOMING

Archaeological investigations on the upper Snake River in Grand Teton National Park revealed the remains of a large number of bison in equivocal association with cultural materials. Radiocarbon dates from two bone samples indicate an age of ca. 1000 *B.P.,* which is consistent with the geomorphic chronology. Previous systematic studies have presented several views on the taxonomy of bison in the Rocky Mountains. One view argues for a sub-specific clinal form, *Bison bison athabascae,* extending from Alaska to the southern Rocky Mountains along the corridor of the mountains. More recently, it has been argued that bison in the Rocky Mountains represented a range extension of the plains bison *(Bison bison bison).* Based on historical illustrations and photographs, some authors have argued that the plains bison comprised at least two distinct geographic forms. Multivariate metric analyses of cranial and post-cranial remains from the Grand Teton sample in comparison with other published studies are presented in an attempt to address this issue.

C. Wesley COWAN, Bruce D. SMITH, and Michael P. HOFFMAN,
Cincinnati Museum of Natural History
NEW PERSPECTIVES ON A FREE RANGING CUCURBIT IN EASTERN NORTH AMERICA

Recent fieldwork has added to a growing body of botanical literature that suggests a wild squash is widely distributed throughout the lower Mississippi River drainage of North America. In this paper we summarize distributional data gathered from field observations and a survey of regional herbaria; we also provide information on the habitat and life history of the plant.

Sandra L. DUNAVAN, University of Michigan, Ann Arbor
FORT ANCIENT PALEOETHNOBOTANY: NEW DATA AND PERSPECTIVES

The groups of people that archaeologists classify as Fort Ancient societies lived along the middle Ohio Valley and its tributaries from the eleventh to the seventeenth centuries *A.D.* Native cultigens and wild or weedy plants were integral to Fort Ancient groups in some areas, although the use of these plants has been overshadowed by our preoccupation with corn and our ignorance of regional and temporal differences within the ''Fort Ancient'' concept. Botanical analysis from the protohistoric Madisonville site, compared with other Fort Ancient area sites, illustrates the diversity of Fort Ancient economic strategies.

Roy ELLEN, University of Kent at Canterbury
SYMBOLIC AND ETHNOBOTANICAL ASPECTS OF NUAULU BETEL-CHEWING

Nuaulu betel-chewing is simultaneously a mundane daily activity and a highly-charged symbolic practice. This paper explores ethnobotanical issues in relation to the full range of social meanings for a part of eastern Indonesia where its character is fast changing. Special attention is paid to the relationship between the expression of different kinds of sociality and altered somatic states.

Judith FANDRICH, P.O. Box 140055, Gainesville, FL 32614
THE SALADOID COMMITMENT TO A TROPICAL FOREST FOODWAY: THE PEARLS SITE, GRENADA, WEST INDIES

Certain South American mammals are present in the excavated material recovered from the Pearls site, Grenada, West Indies. In this paper I attempt to explain the presence of such animals as an Amerindian commitment to tropical forest food resources and familiar hunting strategies. The successful introduction of South American animals into the West Indies allowed the establishment of a reliable food resource, and, undoubtedly, eased the transition to an island economy.

Charles T. FAULKNER, University of Tennessee, Knoxville, and
George M. CROTHERS, Washington University, St. Louis

MORPHOLOGICAL VARIATION IN *Iva annua* ACHENES: A STATISTICAL ANALYSIS OF ARCHAEOLOGICAL COLLECTIONS FROM EASTERN NORTH AMERICA

Domesticated *Iva annua* from archaeological collections is characterized by larger achenes than those of modern wild populations. A statistical analysis of *Iva annua* achene length, and length–width measurements for 52 archaeological collections, was undertaken to assess patterned variability within and between selected collections and time periods. Coefficients of variation calculated for achenes collected from modern wild populations, and archaeological achenes from Salts Cave, KY, Big Bone Cave, TN, and Toqua Mound, TN, indicate that wild populations are more heterogeneous than the prehistoric domestic populations. Kruskal–Wallis nonparametric analysis of variance also indicates that prehistoric domestic *Iva* achenes from the Late Archaic through Mississippian culture periods form a single homogeneous group that is discrete from the modern achenes. Additional analyses of collections from Early Woodland and Mississippian period sites failed to reveal any significant differences in the mean size of the achenes between sites from the same time period.

Catherine S. FOWLER, University of Nevada, Reno

ETHNOGRAPHIC SUBSISTENCE SYSTEMS IN MOHAVEAN ENVIRONMENTS IN THE GREAT BASIN

Great Basin ethnographic subsistence systems have largely been defined and characterized as focused on cold desert resources. However, a significant number of native peoples of the region lived in and depended upon resources in hot desert enviroments, especially those of the Mojave Desert. By focusing subsistence on certain key Mojavean floral and faunal features, such as legumes, agaves, and yuccas, as well as desert bighorns, small mammals, and certain reptiles, all of these groups learned to cope with the Mojave's seeming harshness. In historic times, these groups also supplemented these natural products with several derived from garden horticulture using Mexican–derived cultigens. In this paper, I review and discuss data on the distribution and character of subsistence complexes focused on indigenous Mojavean and introduced resources to achieve a better definition of Great Basin subsistence regimes in general.

Bill GRANTHAM and Brian HESSE, University of Alabama at Birmingham

CUISINE BASED ZOOARCHAEOLOGY: UNDERSTANDING HORIZONTAL DISTRIBUTIONS OF FAUNAL REMAINS

Several models are currently in use in zooarchaeology to interpret the horizontal distributions of faunal remains on a site in terms of relative social status

of households and to attempt to understand the organization of animal production and distribution. Current models assign significance to bone fragments based on an etic grid of meat values. Recent research in a Druze village in the Golan Heights provides an alternative emic approach to the understanding of meat production, distribution, consumption and the disposal of bones. Some aspects of this emic alternative and their application to the interpretation of faunal remains from archaeological sites are discussed with reference to a sample of bones from the site of ancient Qasrin.

Kristen J. GREMILLION, Smithsonian Institution, Washington, D.C.
CROP AND WEED IN PREHISTORIC EASTERN NORTH AMERICA: THE *Chenopodium* EXAMPLE

Archaeological studies of prehistoric crops often focus on timing the transition from wild ancestor to domesticate and establishing criteria for distinguishing between the two. Morphometric analysis may, however, reveal more complex patterns of variation. Studies of fruit morphology in prehistoric *Chenopodium berlandieri,* for example, indicate continuing utilization of an array of *Chenopodium* populations subject to different degrees of human influence rather than a simple replacement of wild by domesticated forms in the archaeological record. Based on comparison with modern crop/weed complexes, archaeological evidence is consistent with ongoing genetic and ecological interaction between domesticated *Chenopodium* and related weed populations in the eastern United States.

Elaine JOYAL, Arizona State University, Tempe
PALM ETHNOECOLOGY IN SONORA, MEXICO

Palms are among the most economically important wild plant species in the Sonoran foothills of northwestern Mexico. Present–day and prior use of Sonoran palms, mostly for thatching and weaving, have been documented for indigenous and mestizo groups. Their management and conservation practices have not been addressed. Initial data on species use and management are presented. I am working in predominantly mestizo communities but two have significant indigenous populations and all have a strong indigenous influence.

Sabal uresana is the most economically important native palm and may be over-exploited in northwestern Mexico. It is preferred over *Erythea* spp. for weaving and thatching. Fully expanded palm leaves are used for thatch and the unopened *cojoyos* are used for weaving mats, baskets, and hats. Springtime appears to be the major harvest time for palm leaves; palms are harvested according to lunar cycles in several areas, as is common in other parts of Latin America. Burning is a common management technique.

Frances B. KING, Jennie COHEN, Susannah HAWKINS, and Renee BONZANI, University of Pittsburgh, PA

EARLY NINETEENTH CENTURY URBAN PLANT USE IN PITTSBURGH, PENNSYLVANIA

Well-preserved, uncarbonized food remains and other debris were recovered from a series of early nineteenth century wells in downtown Pittsburgh, Pennsylvania, excavated by the University of Pittsburgh in 1982 prior to the construction of the downtown subway. The wells were originally abandoned because of water-table contamination and subsequently used for refuse. The well fill is stratified and gives a good record of the types of plant and animal foods used, and the seasonal pattern of usage. Approximately 40,000 seeds were recovered and include several types of squash and pumpkins, cucumbers and muskmelons, watermelons, tomatoes, peppers, apples, numerous kinds of plums and grapes, cherries, peaches, coffee, broad beans, native and imported nuts, and hemp.

H.V. KUHNLEIN, D. APPAVOO and N. DOOLAN, McGill University, Montreal

NUTRIENTS AND ORGANOCHLORINES IN THE TRADITIONAL FOOD SYSTEM OF THE SAHTU DENE/METIS

The food system of the Sahtu (Hareskin) Dene/Metis of Fort Good Hope and Colville Lake, Northwest Territories, was evaluated for human intake of selected nutrients (energy, fats, protein, iron, zinc), and the organochlorines toxaphene and polychlorinated biphenyls (PCBs). In these communities, a total of approximately 130 homes and 560 individuals were interviewed for food use and nutrient intake, and food samples were collected for analysis. It was found that the average percentage energy contribution of traditional Dene foods for adults varied from 26% (women, summer) to 58% (men, women, winter outpost camps). Fish and land mammals were the primary types of foods used. Total fat intake from the Dene foods was on the average less than half that contributed by market foods, and the Dene foods had a more positive balance of polyunsaturated to saturated fats. Protein, iron, and zinc contributions from Dene foods regularly exceed recommended intake levels. On the other hand, fish contained toxaphene, and mammals PCBs, in levels greater than anticipated; however, diets remained within HWC ''Acceptable Daily Intake'' levels for these substances. (Supported by the National Health Research and Development Program, Canada.)

Jenna T. KUTTRUFF and Marie S. STANDIFER, Louisiana State University, Baton Rouge, LA

VEGETAL CORDAGE FROM BAYOU JASMINE, LOUISIANA

The recovery of vegetal cordage from prehistoric archaeological sites in Louisiana is extremely rare. This sample from Bayou Jasmine consists of 18 specimens of finely braided cordage, which may date as early as 1500 *B.C.* Found with the cordage was a portion of a plant that appears to be the source of the

fiber. Taxonomic studies of the plant part were carried in simultaneously with anatomical and technological investigations. Studies with SEM and light microscope indicated that the fiber strands in the cordage are similar in anatomy to appendages on the plant part, which have tentatively been identified as fern stipes. Technological analysis indicates that the cordage varies from 4– to 10–strand braids with a mean diameter of 1.4 mm. The majority of the fibers are split, but a few of them are whole. Considering the site location, one possible end use of the cordage would be as fishing line. The research is expected to continue until the plant source of the fiber has been identified.

Joseph E. LAFERRIERE, University of Arizona, Tucson.
Lawrence Award Winner
A DYNAMIC NONLINEAR OPTIMIZATION STUDY OF MOUNTAIN PIMA ETHNOBIOLOGY

A dynamic nonlinear optimization analysis of subsistence patterns of the Mountain Pima of Chihuahua, Mexico, included requirements for adequate amounts of calories, calcium, vitamin A, vitamin C, and balanced protein. Two models were compared: time minimization and a nutrient indexing method which involved minimization of the product of the factor (1–abs(ln(RDA/Intake))) calculated for all months and nutrients in question. Oxalate composition of some resources and seasonal variation in resource availability were taken into account. In a year of adequate yields, the optimal diet using the time minimization method consists of maize, wheat, potatoes, peaches, chayote, and four noncultivated plant species. Cow cheese was also included in the optimal diet, but not goat cheese. Hunting was excluded during June, July, August, and October, but included in other months. During the drought year of 1988, wheat and potatoes were excluded from the optimal diet, but beans and seven noncultivated plants were included. The nutrient indexing method predicted more reliance on animal resources for both good and bad years, and a wider variety of wild plant species. These predictions agreed more closely with observed intake patterns than did the time minimization model.

Neal H. LOPINOT, SIU–Carbondale, **Gayle J. FRITZ,** Washington University, St. Louis, and **John E. KELLY,** SIU–Edwardsville
THE ARCHAEOLOGICAL CONTEXT AND SIGNIFICANCE OF *Polygonum erectum* ACHENE MASSES IN THE AMERICAN BOTTOM REGION

Direct and indirect evidence for the prehistoric cultivation of erect knotweed (*Polygonum erectum* L.), along with other native seed types in eastern North America, is increasing. Several achene masses have been recovered recently from early Emergent Mississippian contexts at the Westpark site (11–Mo–96), located in the central portion of the American Bottom region. Knotweed achenes in these masses exhibit considerable morphological variability, although they are dominated by smooth, long fruits with thin pericarps. The archaeological con-

texts, morphological diversity, and metric attributes of these and other erect knotweed populations from the central Mississippi Valley are evaluated with respect to domesticatory conditions and agricultural developments.

Gary J. MARTIN, University of California, Berkeley
LOCAL COLLECTORS AND ETHNOBOTANICAL INVENTORIES

I present data on the efficiency of local collectors who are making ethnobotanical inventories in two indigenous communities of the Sierra Norte of Oaxaca, Mexico. In a Mixe village, a single collector has made more than 1600 voucher specimens in the cloud and pine–oak forests. In a Chinantec municipality, five collectors have gathered an equal number of plants in the distinct ecological zones of the community.

I discuss the order in which categories of distinct ranks have been disclosed in the course of this botanical collecting. In addition, I compare the scope of the botanical nomenclature represented in the specimens of the Mixe collaborator with that reported in a community–wide interview on useful plants. Based on these two experiences, I address the question of whether local collectors are capable of providing a complete inventory of local botanical categories and of the local flora.

Darrel McDONALD, Stephen F. Austin State University, and
Elizabeth HEAD, University of Texas Medical Branch, Galveston
***Nerium oleander* VARIETIES ON GALVESTON ISLAND TEXAS: A TASK OF CREATING A TAXONOMY**

From the National Oleander Society established in 1967 at Galveston, Texas the International Oleander Society emerged to promote the proper care, identification, and dissemination of correct information concerning *Nerium oleander* L. Presently the society is developing a systematic key to support and clarify a much longer existing folk taxonomy. Oleanders have been cultivated on the island since 1841. Since then, determined gardeners have nurtured and increased the population of oleanders to a present population of more than one million plants. Over the years a folk taxonomy arose and by 1941 more than 60 varieties were named in honor of prominent Galvestonians and other public figures. Some of these endemic cultivars have been lost but over 40 remain on the island. The society is preparing a key for the varieties to document their botanical standing more clearly. Oleanders have subtle color, fragrance, and morphological difference making the key difficult to organize and verify with type specimens.

Naomi F. MILLER, University Museum, Philadelphia
ARCHAEOLOGICAL CONTEXT AND THE INTERPRETATION OF BOTANICAL REMAINS FROM GRITILLE AND OTHER EARLY AGRICULTURAL SITES (PPNB) IN THE NEAR EAST

In contrast to the North American pattern, the development of agriculture in the Near East was characterized by the essentially simultaneous adoption of

cereals and pulses, the apparent predominance of pulses at some sites, and ultimately the domestication of herbivorous mammals. The adoption of agriculture in the Near East was not, however, uniform. Although varied deposition, preservation, and recovery processes complicate interpretations, archaeobotanical assemblages from three seventh millennium *B.C.* (PPNB and related) sites in piedmont, steppe, and mountain regions show local variation in plant use. All have domesticated plants and no osteological evidence of animal domestication.

At Gritille (southeastern Turkey), a burnt layer yielded a high proportion of pulses. A brief comparison with materials previously published by Willem van Zeist from Cayönü (in the mountians, but closely related to Gritille) and Aswad (Syria) show differences that are attributable to local environmental conditions, but the circumstances of charring (food processing and fuel burning) must also be taken into account.

Rafael MONROY and **Hortensia COLIN,** Biological Investigations Center, CIB, Universidad Autónoma del Estado de Morelos, México

ETHNOBOTANY OF TRADITIONAL FRUIT AGROECOSYSTEMS IN MORELOS, MEXICO

Agroecosystems are productive units, a synthesis of traditional management processes, and an expression of the cultural significance of wild and cultivated plants, especially of native species with respect to introduced species. In this paper we present a case of significant ethnobotanical management of fruit tree diversity. The method included the investigation of richness of cultivated fruit tree species and of the natural environments of temperate and tropical deciduous forests. The average value for the units of cultivated fruit trees in the temperate area was 29 species, while for the tropical zone the diversity average was 6 species. The temperate forest was found to be low in diversity in the arboreal strata, whereas such diversity .is high in the tropical forest. Traditional management of agroecosystems is, in general, characterized by richness of species. This is a function of edible plant availability within the natural vegetation around the communities. The case studied shows that people do not reproduce their ecosystems in their fruit agroecosystems when the latter have an indigenous origin and management, a conclusion that has been reached in other studies.

Steve PATTERSON, University of California, Los Angeles

YUCATECAN MAYA CEREMONIAL PLANT USE

Three instances of the ceremonial use of plants in contemporary Mayan communities are described—the fiesta for a community's patron saint, ***cha chaak*** rain-petition ceremonies, and the Days of the Dead. These uses are discussed in light of Spanish-Catholic and Mesoamerican traditions and the biogeography of the species involved.

Both the patron saint fiestas and the ***cha chaak*** involve the construction of arches—one covered with flowers, the other made of leafy branches. The construction of flower-covered arches is a well-documented Mesoamerican tradition.

The patron saint fiestas, however, are largely derived from Spain. The most important flower used in Yucatecan arches is *Plumeria rubra,* an indigenous species with precolumbian religious significance. The ***cha chaak*** is a basically indigenous ritual. In the leaf-covered arches of the ***cha chaak*** the most important species are native, but some introduced species are also used. Ceremonies of the Days of the Dead in Yucatan contrast sharply with those described from other parts of Mexico. Marigolds *(Tagetes* spp.) are not of much significance. The celebration of these ceremonies is waning or being transformed by changing social and economic conditions.

Sandra PEACOCK, University of Calgary, Calgary, Alberta, Canada
IN SEARCH OF THE SACRED TURNIP: USING BLACKFOOT MYTH TO ASSESS THE CULTURAL SIGNIFICANCE OF *Psoralea esculenta*

Ethnographic and archaeological evidence provides few direct insights as to the importance of the prairie turnip, *Psoralea esculenta,* in the diet of the Blackfoot Indians of the northwestern Plains. If the cultural significance of this resource is to be evaluated, then alternate sources of data must be investigated. Several important Blackfoot myths concern the ''sacred turnip'' and its relationship to the Sundance ceremony. In this paper I examine these legends and suggest they are valuable indicators of the cultural significance of the prairie turnip to the prehistoric Blackfoot.

Donna L. RUHL, Florida Museum of Natural History, Gainesville, FL
PRELIMINARY PALEOETHNOBOTANICAL DATA FROM NATIVE AMERICAN CONTEXTS ASSOCIATED WITH SPANISH MISSION COMPLEXES

In the past, Spanish Mission research in *La Florida* has favored and generated data from primarily Hispanic contexts in Spanish Mission complexes. Recently, attempts to correct this bias have included sampling and research strategies including excavations in Indian habitation areas (e.g., council houses, village structures, associated features). To date, three seventeenth century sites have been reported. Analysis of paleoethnobotanical remains from a fourth site believed to be the aboriginal village associated with the mission of Santa Catalina de Guale on Amelia Island, FL, has indicated traditional plant uses as well as new adaptations and adjustments resulting from Hispanic contact and interrelationships.

Sylvia SCUDDER, University of Florida, Gainesville, FL
CHARACTERIZATION OF ANTHROPOGENIC SOILS FROM A SOUTHWEST FLORIDA NEARSHORE ISLAND

Anthropogenic soils developed on Pleistocene aeolian dune sands were characterized and compared with native soils (hyperthermic uncoated Typic and Spodic Quartzipsamments) in a coastal subtropical insular environment near

Marco Island, FL, to document pedogenesis in 20 known-age (4700 *B.P.* to *A.D.* 1870) archaeological deposits. Samples were analyzed for particle-size distribution, carbon content, pH, and phosphate content. Particle-size analysis revealed the dominance of the fine sand fraction (84.7% by wt.). Organic carbon contents ranged from 5.23% in Archaic Period (4700 *B.P.*) epipedons to 0.16% in non-midden epipedons. In all soils organic carbon decreased with depth. The pH ranged from 4.7 in native soils to 8.75 in midden soils overlain by oystershell. Total phosphate values were used to delineate midden versus non-midden areas where shell overburden had been removed. These analyses will be coupled with paleobotanical, zooarchaeological, and archaeological studies to reconstruct the paleoenvironment of these nearshore islands.

G.K. SHARMA, University of Tennessee, Martin
THE HIMALAYAS: AN ENDANGERED ECOSYSTEM

The Himalayas extend from Afghanistan to Burma with some of the highest peaks in the world, including Mt. Everest—the world's highest peak. This pristine ecosystem is the home of highly unusual flora and fauna. Its antiquity and remoteness have long affected the human cultures of the area. Unfortunately, this fragile ecosystem is in danger of being destroyed by modern activities, such as overpopulation, industrialization, cultivation, and environmental pollution. Uncontrolled tourism is one of the latest factors creating havoc in these mountains. Opening the mountains to heavy vehicular traffic to enhance industrial growth, and the migration of human populations to the salubrious high altitude climate have affected the topography, biological balance, and human cultures of the area. Ethnobotanical lore is disappearing and the ethnomedicinal treasure-trove of these pockets of antiquity is being obliterated. Remedial measures are badly needed to reverse the trend. In this poster exhibit I describe a systematic study of the medicinal flora of the area that has been in progress for the last four years. (Portions of this study were supported by the Rotary International and the University of Tennessee at Martin.)

Marie S. STANDIFER, Shirley C. TUCKER, and **William J. BLACKMON,** Louisiana State University, Baton Rouge
DIAGNOSTIC CHARACTERS IN CHARRED TUBERS OF *Apios americana* MED.

The identification of charred tuber fragments in archaeological samples is difficult because the anatomy of many tuberous native plants has not been described. In this paper we report a study of the tubers of groundnut (*Apios americana* Medicus), a food source of historic Indian tribes and a component of many archaeological samples. The SEM and light microscope were used to investigate fixed, experimentally charred, and archaeological tuber specimens. It was found that latex cells and xylem elements persist after charring and can be used to determine the position of the vascular bundles and thus identify tuber

fragments. Although expensive, the SEM proved a valuable tool in searching for diagnostic traits, which were then located with the light microscope.

J. Dale THOMPSON and **Irwin ROVNER,** North Carolina State University, Raleigh

MORPHOMETRIC CLASSIFICATION AND IDENTIFICATION OF *Cucurbita* USING EXPERT VISION IMAGE ANALYSIS

Reports of successful classification of squash and pumpkin seeds based on size parameters were verified using the ImagePlus II expert vision system. Seed populations of two varieties each of pumpkin, winter squash, and summer squash were tested using 12 parameters of size and shape including area, length, breadth, perimeter, roundness, aspect ratio, and convexity. Size factors provided consistent, high confidence (greater than 99%) population separation in most cases using any one of the parameters. When less than 99% confidence occurred, any alternative size parameter usually provided separation at greater than 99%.

Seed shape was more often consistent, failing to distinguish cucurbit seed populations. This suggests easy separation from non–cucurbit seeds based on shape, while size readily identifies varietal populations. A blind test of mixed seed populations produced significant results in identifying individual seeds using morphometric parameters.

Nancy J. TURNER, Royal British Columbia Museum, Victoria

BURNING MOUNTAIN SIDES FOR BETTER CROPS: ABORIGINAL LANDSCAPE BURNING IN BRITISH COLUMBIA

Controlled burning of vegetation was a common technique among indigenous peoples of British Columbia. Burning enhanced the growth and production of certain food plants, including camas *(Camassia* spp.), yellow avalanche lily *(Erythronium grandiflorum),* tiger lily *(Lilium columbianum),* spring beauty *(Claytonia lanceolata),* nodding onion *(Allium cernuum),* hazelnut *(Corylus cornuta),* black mountain huckleberry *(Vaccinium membranaceum)* and other *Vaccinium* species, wild raspberry *(Rubus idaeus)* and blackcap *(R. leucodermis),* as well as game forage plants. There is little quantitative documentation of these burning practices. However, according to contemporary elders and diverse ethnographic and historic sources, burning of meadows, mountain slopes, and some individual fruiting plants occurred prehistorically and within the historic period into the early 1900s in many areas of British Columbia, as it did in other parts of North America.

Abundance and productivity of some traditional food plants is said to have decreased in recent decades due to active fire suppression practices of the British Columbia government. Successional plant communities that follow logging are productive for wild berries and other traditional foods. Herbicide application in reforested areas reduces the growth of non–commercial tree and shrub species, and may place at risk the traditional harvesting of wild foods and medicines by indigenous peoples.

Gail E. WAGNER, University of South Carolina, Columbia
CORN FROM THE ANGEL SITE, INDIANA

The Angel site (12Vg1) is a Middle Mississippian, Angel phase, civic–ceremonial center located on the Ohio River in southwestern Indiana and occupied from approximately *A.D.* 1150–1500. Isotopic analyses (13C and 15N) of human remains indicate that diets were relatively uniform by sex and age as well as throughout the approximately 150 years of occupation represented by analyzed burials. Corn from the site is examined for uniformity and variability, and the collection is compared to contemporaneous Fort Ancient collections from further up the Ohio River.

Paula WAPNISH and **Brian HESSE,** University of Alabama, Birmingham
THE ASHKELON DOG CEMETERY?

A total of 808 dog ''finds'' have been recovered from Ashkelon, a major port city on the southern coast of Canaan. Almost all of these can be dated to a relatively brief segment of the Persian Period, ca. 500–400 *B.C.* Moreover, most of the finds so far are complete or partial skeletons interred in a few unmarked concentrations in the center of the site. In this paper we survey the morphology and demographic characteristics of this singular zooarchaeological find and situate it in the cultural mix of attitudes towards dogs likely to have affected ancient Canaan.

Steven A. WEBER, University of Pennsylvania
REVOLUTION OR EVOLUTION? MODELS OF SUBSISTENCE CHANGE IN ANCIENT SOUTH ASIA

Archaeological evidence appears to show that from the third millennium *B.C.* to the Iron Age there had been successive swings towards and away from urbanism and cultural uniformity throughout the area of the Harappan civilization. These shifts have been speculatively tied to transformations in subsistence strategies, but the exact nature and extent of their relationship is still unknown. In this paper I suggest new ways to approach subsistence, settlement, and material culture in prehistoric South Asia, addressing in particular the question of whether subsistence changes were as dramatic and rapid as ones in material culture appear to have been.

Timothy S. YOUNG, Mercer University
FISHING TECHNIQUES OF THE CONTACT PERIOD COMPONENT FROM THE FOUNTAIN OF YOUTH PARK ARCHAEOLOGICAL SITE ST. AUGUSTINE, FLORIDA

Because evidence of fishing techniques is rare in the ethnohistorical literature, inferences must be made from other fields like zooarchaeology. One hundred seventeen Sciaenidae otoliths, representing 8 species, were recovered from the

contact period component of the Fountain of Youth archaeological site (8–Sj–31), St. Augustine, Florida. The size of each fish was estimated from measurements of the otoliths using the allometric formula. The mean standard length was estimated to be 129 millimeters, and the range was 55.5–224.3 millimeters. The estimated size, along with the life history of sciaenids, suggests that nets or baskets with a minimum mesh size were used to catch the large number of small fishes.

BOOK REVIEW

El Códice Florentino, Su Información Etnobotánica. Erin Ingrid Jane Estrada Lugo. Chapingo, México, México: Colegio de Postgraduados. 1989. xvii, Pp. 339. 35,000 MN (Mexican pesos) (softcover). ISBN 968–839–077–1.

The availability of translations and facsimiles of sixteenth century documents of central Mexico enhances ethnobotanical studies. Careful indexing of these historical references makes them accessible to scholars. Using the facsimile edition of the Florentine Codex (Sahagún 1979) and Dibble and Anderson's (1950–1982) English translation of the same along with one English publication and seven Spanish references, Ms. Estrada has compiled information on the use and nomenclature of plants according to the Nahuatl Indians of Mexico during the mid–1500s and on the plants' probable contemporary botanical identifications. No new or alternative identifications for the plants are provided.

After a brief introduction to Mesoamerica and the ethnobotany and agriculture in the region during prehispanic and early colonial periods, the complicated history of the Florentine Codex (also known as the General History of the Things of New Spain) is summarized. Fray Bernardino de Sahagûn, a monk who arrived in New Spain in 1529, began collecting data in 1558 with the assistance of the Nahuatl Indians from central Mexico. Based upon earlier manuscripts, the Florentine Codex was completed in 1579 or 1580 and then sent to the King of Spain. The Codex consists of 12 books which are bound into three volumes. The number of plants (listed in parentheses) in each book are as follows: 1 (22), 2 (55), 3 (11), 4 (15), 5 (11), 6 (15), 7 (9), 8 (49), 9 (25), 10 (188), 11 (527), and 12 (1). Book 11, which has the most references to plants, deals with natural history. Book 10 treats among other topics the human body, and its illnesses and remedies.

Using a computerized data base program (dBase III), Estrada gathered data from these nine references and standardized their citation using the 1979 facsimile edition. The general results are presented in summary tables on pages 56–86. The most useful part is found on pages 87–392 where the printouts of 22 data base sortings are reproduced and include: scientific names (along with families, common Nahuatl names, and location in the texts), botanical families, and use categories. These last sortings are based upon Nahuatl names in the Florentine Codex and are presented according to the following anthropocentric plant uses (the number of plants in each is in parentheses): medicinal (266), edible (229), ceremonial (81), ornamental (48), industrial (27), stimulatory (20), fuel (14), construction (14), forage (14), dyes (12), fibers (8), resins (8), tribute or tax pay-

ment (4), condiments (3), poisonous (4), gums (1), narcotic (1), and toys (1). The final data summary names plants with no use and without botanical identification.

This book, with its numerous cross-indexed tables, is a basic guide for researchers who need to consult Sahagún's historical ethnobotanical source. Nonetheless, the reader should be aware of possible limitations, such as omissions and typographical errors. For example, *Coutarea latiflora,* known as **chichic quauitl** in Book 11, Chapter 6, paragraph 3 (Dibble and Anderson 1963:111) should be on page 14 of "Relación de plantas ordenadas por nombre científico" (or 6.7, Rponci) but is not found here or under its currently accepted name, *Hintonia latiflora* (page 24 of the same list), even though **chichicquauitl** is listed twice in "Relación de las plantas con uso medicinal ordenadas por nombre común" (6.9.1, page 4).

Another example is **uauhquilitl** (Book 11, Chapter 7, paragraph 3) for which Dibble and Anderson (1963:134) cite *Chenopodium nuttalliae* as one of four possible botanical identifications, but it is not found in the list (6.7, Rponci, page 13). Another candidate for this plant, *Amaranthus cruentus* (Dibble and Anderson 1963:134), is not found but one of its synonyms, *A. paniculatus,* is listed. The amaranth interpretation is further confused by either a typographical or nomenclatural error (6.7, Rponci, page 5) in which "Saff." as well as "Seff." are each listed as the varietal author of *Amaranthus paniculatus* L. var. *leucocarpus,* which apparently has not been registered (Sauer 1967). On the other hand, the presumed basionym of this unpublished trinomial, *A. leucocarpus,* was suggested by Dibble and Anderson (1963:134) but is not found as a direct entry in the book. Today, *A. leucocarpus* is a synonym of *A. hypochondriacus* (Sauer 1967) which is incorrectly written once as *Amaranthus hypocondriacus (A. leucocarpus)* S. Watts. (6.7, Rponci, page 4).

Providing Latin botanical names as correlates to Nahuatl plant names forms a critical bridge for future interpretations of Sahagún's work. Estrada checked the scientific names in various standard references but nomenclatural revisions were not considered. Returning to the *Amaranthus* example, it is curious that Sauer's (1950, 1967) classic studies, which included a detailed analysis of **uauhtli**, are cited in the book's bibliography but that his authoritative taxonomic and ethnohistoric conclusions were not incorporated into the study.

The book is relatively inexpensive, which makes it affordable but also places restrictions on additional printing. For instance, the pages of the data base printout lack numbering which is consecutive with the book. Nonetheless, four color plates are reproduced from the 1979 facsimile.

Erin Estrada's contribution marks a major advancement in historical ethnobotany of the Americas. She has laid the groundwork for critical analysis and interpretation of plant–human relationships for a period nearly 450 years in the past. The systematic presentation of ethnobotanical data should aid researchers in their evaluation of the roots of contemporary interactions between the peoples of central Mexico and their plant world. It is worth noting that the original version of the book was her thesis which gained Honorable Mention for the 1988 Efraím Hernández Xolocotzi Award for Mexican graduates who recently completed an advanced botany degree.

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NEWS and COMMENTS

NEWS

BOOK REVIEWERS NEEDED.—The following titles have been received for review in the *Journal of Ethnobiology.*

ATRAN, SCOTT. 1990. Cognitive Foundations of Natural History: Towards an Anthropology of Science. Cambridge University Press, Cambridge, United Kingdom and New York, and Editions de la Maison des Sciences de l'Homme, Paris. 360 pp.

COOKE, MORDECAI C. 1989. The Seven Sisters of Sleep: Popular History of the Seven Prevailing Narcotics of the World. Quarterman Publications, Lincoln, Massachusetts. (Facsimile reproduction of original 1860 edition published by James Blackwood.) 371 pp.

CRABTREE, PAM J., DOUGLAS CAMPANA and **KATHLEEN RYAN.** 1989. Early Animal Domestication and its Cultural Context. MASCA Research Papers in Science and Archaeology, Special Supplement to Volume 6. MASCA, The University Museum of Archaeology and Anthropology, University of Pennsylvania, Philadelphia. 136 pp., large format.

FRADKIN, ARLENE. 1990. Cherokee Folk Zoology: The Animal World of a Native American People, 1700–1838. Garland Publishing, New York and London. (Publication of doctoral dissertations.) 562 pp.

DE MONTELLANO, BERNARD R. ORTIZ. 1990. Aztec Medicine, Health, and Nutrition. Rutgers University Press, New Brunswick, New Jersey, and London. 308 pp.

SPIELMANN, KATHERINE A. (editor) 1991. Farmers, Hunters, and Colonists: Interaction between the Southwest and the Southern Plains. The University of Arizona Press, Tucson. (Conference preceedings.) 217 pp.

VAN ZEIST, WILLEM, KRYSTYNA WASYLOKOWA, and **KARL-ERNST BEHRE** (editors) 1991. Progress in Old World Palaeoethnobotany: A Retrospective View on the Occasion of 20 Years of the International Work Group for Palaeoethnobotany. A.A. Balkema, Rotterdam, and Brookfield. (Some papers in German.) 350 pp.

WAGNER, H. and **NORMAN R. FARNSWORTH** (editors) 1990. Economic and Medicinal Plant Research, Vol. 4: Plants and Traditional Medicine. Academic Press, New York. 174 pp.

If you would like to review any of these books, and would be able to have your review completed within four months after receiving the book, please write to:

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HATHER THESIS NOW AVAILABLE

Power to the people does work! As a direct response to those who requested it, the Center for Research Libraries has purchased a microfilm of the Hather thesis from the University of London. Your interlibrary loan can obtain it from the CRL in Chicago by asking for: *The Morphological and Anatomical Interpretation and Identification of Charred Vegetative Parenchymatous Plant Remains,* by Jonathan G. Hather, Ph.D. thesis, Institute of Archaeology, University College, London. 1988.

For those of you who did not receive my flyer, the thesis is a SEM study of the edible charred roots and underground plant parts of 71 taxa. Many of the genera studied have representative species in North America. A few of them are *Acorus, Alisma, Anemone, Arctium, Brasica, Cyperus, Daucus, Dryopteris, Erodium, Eryngium, Gentiana, Heracleum, Hordeum, Inula, Lathyrus, Lithospermum, Nuphar, Nymphaea, Oenothera, Orchis, Polygonum, Polypodium, Potentilla, Pteridium, Ranunculus, Sagittaria, Scirpus, Sparganium, Taraxacum,* and *Typha.* In addition to information about the affects of charring on tissues, the thesis provides criteria for distinguishing among fragments of parenchymatous tissue, wood, seed, and dung using only the lower magnifications of an ordinary binocular microscope. It also presents the first attempt at a dichotomous key based both on characters resulting from charring and on anatomical and morphological characters.

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INDIAN NAMES FOR PLANTS AND ANIMALS, AMONG THE CALIFORNIAN AND OTHER WESTERN NORTH AMERICAN TRIBES AVAILABLE ON DISK

A computer disk is now available that contains the Amerind plant names only (excluding the animal names) from C. Hart Merriam and Robert F. Heizer's 1979 edited publication, *Indian Names for Plants and Animals Among the Californian and Other Western North American Tribes* (Ballena Press, Publications in Archaeology, Ethnology and History No. 14). This disk is distributed with the permission of Ballena Press, 823 Valparaiso Ave., Menlo Park, California 94025 "WITHOUT RELINQUISHING ITS COPYRIGHT RIGHTS WITH RESPECT TO ANY OTHER USE OF MERRIAM'S BOOK." A copy of the computer disk can be purchased for $10 (absolutely no purchase orders will be accepted) by sending your request with a check or money order to: Greg Shadduck, 3508 45th Avenue South, Minneapolis, Minn. 55406.

The data in the book are Amerind names of plants and animals, collected in California in the early twentieth century. The book, however, is difficult to use because it presents the data in only one of a number of possible sequences, that is, by name of people and, within that, by code number for each plant. Greg Shadduck has re-keyed the data concerning plants (ignoring an equal or larger quantity pertaining to animals) and has employed additional sorting techniques. The information is now contained on a disk that is available for distribution. Ballena Press will not market the disk, but they have granted permission to us to distribute a limited number of copies of the disk at cost. The label on the disk envelope reads as follows:

> LAWRENCE, D.B. & SHADDUCK, G. (1990). Computerized READ ME file and transcription into ASCII text files of *the plant part only of:* MERRIAM, C. HART & HEIZER, ROBERT F., editor. (1979). Indian Names for Plants and Animals Among the Californian and Other Western North American Tribes. (Ballena Press Publications in Archaeology, Ethnology and History No. 14). 296 pp. ISBN 0–87919–085–X. Disk distributed with permission of Ballena Press, without relinquishing its copyright rights with respect to any other use of Merriam's book. This is Copy No. _____. [Four pages of explanatory text accompany the disk.]

Perhaps this effort may stimulate others to organize the animals portion of the Merriam and Heizer book in this same way. Furthermore, we hope our disk may serve as a model for organizing a worldwide compendium of aboriginal names, especially of plants and animals, and of geographic names and terms as well. For international coverage of vernacular names of plants in many languages, we have encountered nothing as comprehensive as that published in the second edition (1935) of the four–volume treatise *Indian Medicinal Plants* by K.R. Kirtikar, B.D. Basu, and An, which was published in Allahabad, India, by Lalit Mohan Basu. This was the last edition in which such names were included. We know of nothing comparable for vernacular names of animals of the world. For place names, nothing surpasses the multivolume computerized list of names of post offices of the world, which is revised periodically and published by Union Postal Universelle, Berne, Switzerland, with the title *Nomenclature Internationale des Bureau de Poste.* Geographic terms in regional languages appear on various maps published by the National Geographic Society. Also, there are several dictionaries of human geography.

The methods used in the preparation of our disk, if applied to names of places and geographic terms as well as to plant and animal names, should provide an important tool for helping to trace human migrations over the face of the earth.

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INTRODUCTION OF THE *JOURNAL OF ETHNOBOTANY*

We have the pleasure of informing you that a new journal, *Ethnobotany,* has recently been introduced in India by Deep Publications. This journal, the first

issue of which was released in March 1990, is devoted to research papers, review articles, and news on ethnobotanical topics such as ethnomedicine, ethnoagriculture, ethnopharmacology, ethnoenvironmental botany, pharmacognosy, and phytochemistry.

The close relation between man and natural–plant resources is evident in all human societies, but it is most significant among the relatively primitive ethnic groups. There is worldwide interest in the study of this relation. This journal has been brought out in collaboration with the Society of Ethnobotanists, keeping in view the long felt need for a journal of international standards on this interesting subject.

It is hoped that the journal will be useful for scientists, medical specialists, students, teachers, medical practitioners, and manufacturers of pharmaceuticals. It is our belief that the journal will be useful for the library of your institution. Suggestions for improvement of the journal (contents and production) will be appreciated and individually acknowledged.

To subscribe to *Ethnobotany* send $50 (U.S. currency) to:

Deep Publications
A–3/27A, DDA Flats
Paschim Vihar
New Delhi–110063 INDIA

Please include $2 per check or money order as a collection charge. Note that the journal will be mailed at the surface rate, however, if you would like to receive it by air mail, please add $4 to your subscription rate.

Other publications of interest from Deep Publications include the *Dictionary of Indian Folk-Medicine and Ethnobotany* by S.K. Jain of the National Botanical Research Institute at Lucknow, and *Notable Plants in Ethnomedicine of India* by S.K. Jain and B.K. Sinhas.

The dictionary is a glossary of all ethnobotanical work done in India. It will instantly inform a reader whether a particular folk use has been reported from India. The book has exhaustive indices and over 40,000 cross references. The main text deals with over 2500 plants, giving their folk uses for medicine, food, other material–culture applications like dyes and tans, mythology, and symbolic relationships; the related plant part, region of India, source of information, and local names are also included.

A glossary–cum–index provides definitions of therapeutic, ethnobotanical and other terms, and it lists genera under approximately two hundred utility categories like anthelmintic, aromatic, diuretic, fibres, skin diseases, taboos, and worship. Other sections include ethnic groups (population, distribution, language, notable references on them), recent works on ethnobotany (address, region and ethnic group of their work, notable publications), an index to families (with lists of their genera), an index of over 4000 local names, and a bibliography of over 375 references.

Notable Plants in Ethnomedicine of India deals with about 200 notable plants (about 40 are illustrated) that are used by the tribal and rural folk in India for curing diseases. Over two thousand plants actually are reported in the literature as medicinal, and a large number of them are now widely used and described

in modern pharmacopoeias, textbooks of Ayurveda and Yunani, and books on medicinal plants.

The authors have compared the recent data on folk medicine with textbooks and have addressed in the present book only such plants that are not well known and should be subjected to phytochemical, toxicity, and clinical tests for their medicinal potential. A review of literature on the chemistry of several species also has been conducted.

The data on each species includes full botanical name, family, brief description, local name, general distribution in India, and time of flowering and fruiting. The folk use is described with available details of method of preparation, dosage, and mixtures of other herbs, if any. The source of ethnobotanical information is cited. The earlier well known uses of the species and known biological activity, if any, are mentioned. Further, to support credibility, a mention is made of any allied species in the genus already known for similar curative properties. Inquiries about these two publications should be sent to the Deep Publications address above.

COMMENT

ETHNOBOTANY and HENRY DAVID THOREAU by Robert A. Bye, Jr.

Even though the term ethnobotany was not coined until 1895, many features that we study today were anticipated by naturalists. Their observations and interpretations provide us with useful historical perspectives for contemporary research problems. Henry David Thoreau (1817–1862) provides an example with his essay, "The succession of forest trees," in *Excursions* (Corinth Books, 1962). This famous American writer, poet, and practical philosopher formed part of the Concord, Massachusetts, transcendentalist community, which was concerned with the essential unity of all creation, the innate goodness of humans, and the supremacy of insight over logic and experience for the revelation of the deepest truths. Although this philosophy of life did not promote an empirical perspective, Thoreau's practical experience as a surveyor of farm woodlots permitted a detailed view of forest dynamics and human activities. This pragmatic approach complemented his interest to "come as near being indigenous to the soil as a white man can" (pg. 135).

His "succession" paper has a peculiar history and can be perceived differently by each reader (W. Harding and M. Meyer, *The New Thoreau Handbook,* New York University Press, 1980). Thoreau based it upon experiences recorded in his journal *(The Journal of Henry D. Thoreau,* Volumes I–XIV, Dover Publications, 1962) between 1852 and 1860. He presented it orally before the Middlesex Agricultural Society in Concord in September 1860, after which it was printed in the *New York Tribune.* Professional publications included its entry in the Society's Transactions for 1860 and in a modified reprint in the Eighth Annual Report of the Secretary of the Massachusetts Board of Agriculture for 1860. S. Thoreau and E. Channing incorporated the work in his posthumously published book, *Excursions,* in 1863. Harding and Meyer (1980:58–60) provide examples of the impact of Thoreau's essay on literature, science, and humor. An ethnobiologist reading it will find

insights related to (1) a model for forest change as a response to human activity, (2) the observation of nature as a guide to resource exploitation, and (3) the transitory aspects of anthropogenic vegetation.

The idea and explanation of ecological succession were in their infancy in the nineteenth century. A few Europeans recognized predictable changes in vegetation sequences (S.H. Spurr, "Origin of the concept of forest succession," *Ecology,* 1952), but it was Thoreau who first coined the term "forest succession" and deciphered the pattern of tree replacement in the United States (W.H. Drury and I.C.T. Nisbet, "Succession," *Journal of the Arnold Arboretum,* 1973). Later, professional ecologists such as Hult in 1885, Cowles in 1889, and Clements in 1905 independently developed the concept (Drury and Nisbet 1973). The American naturalist–writer recognized that, after logging in central New England, the original pine stands were replaced by even–aged hardwood forests. Not only did he call attention to the importance of seed dispersal, especially by wind and animals, from one forest type to another but also the role of the over–story pines as shelter for the under–story oak saplings. Such a natural method could be adopted by humans, as he illustrated with the English experiment of establishing oak forests using pines as nursery trees. This concept is realized today by such ethnobotanically related projects as those at Wes Jackson's Land Institute in Kansas, where cultivation practices are evaluated to meet the expectations of the land, and at Arizona's Desert Botanical Garden, where Gary Nabhan and collaborators are growing "wild" chiltepin hot peppers under such native nursery trees as hackberry.

Thoreau, in "The succession of forest trees," also considered that human sustenance could be satisfied by "adopting the method of Nature" with respect to the seeds in the forest (pg. 148). Animals selected good fruits such as hickory nuts, oak acorns, chestnuts, and pine seeds, removed them from the mother tree, and stored them. Humans could take advantage of not only the animal–stored nuts but also the natural–storage techniques. Thoreau ate animal–gathered nuts as well as other collected plants. He observed that nuts stored with the husks intact and in a mold–leaf heap were preserved over winter in excellent condition. Thoreau concluded this section by suggesting, "Would it not be well to consult with Nature in the outset?" (pg. 152). Systematic comparison of the traditional collection and storage of edible plants by peoples who depend upon seasonally collected food resources with the natural phenomena of their ambient environment would be a fruitful area for ethnobiological investigation.

The role of humans in the appearance of floristic elements otherwise considered unnatural is addressed in his discussion on the "vitality" of seeds. With respect to edible beach–plums (probably **Prunus maritima* Marsh[1]) that germinated in disturbed sand 40 miles inland (i.e., outside their natural range of distribution), Thoreau questioned the explanation based upon seed relics left behind by the receding coast line. He then followed with a personal observation about anthropogenic vegetation associated with buried seed. In 1859 the Hunt House, which was built in 1703, was torn down and plants arose from the cellar of the house thus indicating that "seeds...reproduce long extinct plants," Thoreau was familiar with local flora, as confirmed by his herbarium specimens in the Harvard University Herbaria and by botanical notes in his *Journal;* therefore, his

observations are credible. Five plants, which were either rare or not growing spontaneously in the area, appeared—nettle *(Urtica urens* L.), dill *(Anethum graveolens* L.), Jerusalem oak *(Chenopodium botrys* L.), black nightshade *(Solanum nigrum* L.), and common tobacco *(Nicotiana tabacum* L.). All of these herbs are introduced taxa and apparently sprang from seed which had long been buried under or about the house. The following year, the cellar was filled and four plants disappeared from that locality. Along with these species, Thoreau in his *Journal* (VII:483 and XII:340–342) recorded other plants associated with cellars and abandoned houses—mallows or cheese *(*Malva neglecta* Wallr.), rich-weed *(*Collinsonia canadensis* L.), catnep [suc] *(*Nepeta cataria* L.), chickweed *(Stellaria media* [L.] Cyrillo), beggars-tick *(Bidens frondosa* L.), Jamestown-weed *(Datura stramonium* L.), henbane *(*Hyoscyamus niger* L.), and apple-of-Peru *(Nicandra phsaloides* [L.] Pers.). This nineteenth-century naturalist demonstrated that through movement of seeds and disturbance of soil, humans promote modifications, although sometimes ephemeral, in the composition of the vegetation.

Although a transcendentalist who characteristically shunned empirical analysis of nature, Thoreau's practical insights to nature's puzzles are remarkable. He observed and wrote on ecological themes before the acceptance of Darwinian evolution and the knowledge of genetic mechanisms. The uncertainties and academic frenzy associated with spontaneous generation (abiogenesis), transmutation (i.e., one species changes into another one between one generation to the next), and genetic connection among all individuals of a species (like breeds like) can be best appreciated in the historical context by examining the life of a contemporaneous botanist, such as Asa Gray of nearby Cambridge (A.H. Dupree, *Asa Gray,* Harvard University Press, 1959). Although he appears to have believed in the creation of species and the design of nature, Thoreau in his *Journal* (XIV:330–334) used arguments, similar to those of Gray, of naturalization of the English cherry tree, biogeography of pines, seed dispersal, and suppressed growth of wild black cherry and oaks under pines against such accepted explanations for the sudden appearance of new taxa as independent creation and spontaneous generation. He emphasized the need to know through field observation. During the middle 1800s, orthodox theological and philosophical explanations about the origin and stability of species permeated conventional rationalization for vegetation changes and detracted attention from recognizing human influences on plants, except cultivated plants.

Thoreau's writing came at a critical point in American history. The United States was transforming from a rural economy to an industrialized urban society. There was a trend to lose contact with nature. The transition presented a choice in terms of the values of life: follow a materialistic path or a spiritual path. Such a dichotomy mirrors the early history of ethnobotany, which tended to place more emphasis on the utility and potential industrialization of native plants for the socioeconomically dominant society rather than on the plants' cultural values and functions for indigenous peoples. Also, it may be difficult for us to appreciate Thoreau's academic contribution at a time when the scientific community's attention was shifting from the anxiety of replacing the Linnaean classification for taxa with a natural system to the intensifying inquiry into the origin and nature of species. Today we assume the fundamental principles of natural selection,

ecology, and genetics as requisite in our investigation. These disciplines have developed as a consequence of partitioning the domain of inquiry and have fragmented our view of nature. A review of natural history writings—produced at a time when anthropology, biology, philosophy, theology, and other academic fields were one—could stimulate fruitful areas for ethnobiological research as well as give interdiscipliarnry studies an advantageous perspective.

[1]The Latin binomials are those reported by Thoreau, except those preceded by an asterisk. Scientific and common names were verified using F.C. Seymour (*The Flora of New England*, Charles E. Tuttle, 1969).

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NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting recent issues of the *Journal*. If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

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